Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

FOR ALL POWER ENGINEERS • STEAM, ELECTRICITY AND ALL OTHER POWER ENGINEERING SERVICES

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The PRACTICAL ENGINEER and ELECTRICIAN

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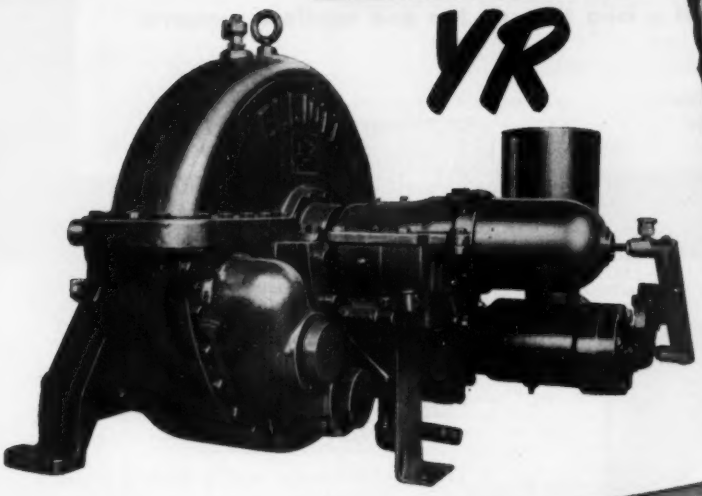
TECHNICAL PUBLISHING COMPANY • CHICAGO, ILLINOIS

JULY 1951

The turbine that
Outdoor installation
Driving induced draft fans
Driving boiler feed pumps
Driving reflux pump
Serving a catalytic unit
High back-pressure turbine
Driving hot oil pumps

everyone likes...

ELLIOTT YR



Driving induced draft fans

Paper machine drives

Driving process pumps

YOU SEE THEM EVERYWHERE—in power plants, industrial and process plants, throughout the oil industry, in fact in all industries that demand reliability in mechanical drive turbines. Working indoors or out, under all kinds of conditions, operating condensing or noncondensing; sometimes operating on gas instead of steam. Although a standardized line of turbines, their flexibility results in a tailor-made unit for any type of application . . . And best of all, with the built-in dependability that lightens the load of the men whose job is to keep things running right.

Everyone likes the Elliott YR. The reasons are factually set forth in Bulletin H-16. Write for it.

ELLIOTT COMPANY

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H-730

A STEAM TRAP MECHANISM GOOD FOR 900°F, 950 PSIG

. . . will last a long time on low and medium pressures

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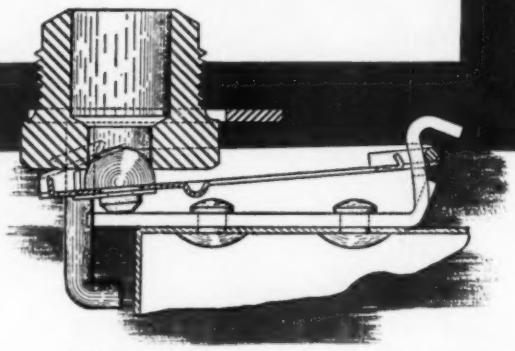
"50% LESS TRAP MAINTENANCE since installing Armstrongs on low pressure vacuum return heating system." . . . John Deere Ottumwa Works, Ottumwa, Iowa.



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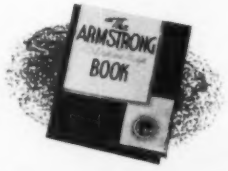

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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

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July, 1951

VOLUME 55—NUMBER 7

Notes on This Issue

Instruments and Controls for Small A-C Generators

The author of this article, Denard L. Gusler, is Chief Engineer for a group of small power plants serving furniture factories owned by Bassett Industries of Bassett, Va. In the small plants that he operates, he finds that one of his principal problems is to show the operating engineers exactly what they are doing when they are operating small alternating current generators driven by small steam turbines and steam engines.

Mr. Gusler points out that the operator may go through a lot of motions on the switchboard in putting a generator on the line and taking it off the line, as well as while it is on the line, but that frequently he hasn't the slightest idea how the instruments and controls work that he uses to do all these things.

Accordingly, this article begins by explaining exactly what the purpose of each electrical instrument on the switchboard is and gives a very brief but accurate definition of just how the instrument works. It then discusses step by step exactly what the operator does and why he does it.

Coal Burning Gas Turbine

Here is the latest Progress Report on the development of the coal burning gas turbine. Mr. Yellott's report is particularly timely because this year there has been very important and interesting progress in developing the gas turbine to burn coal. A great many of the problems that arose a couple of years ago have now been solved, not perfectly but in a sufficiently practical way so we can expect that eventually we are going to have a coal burning gas turbine.

An experimental Houdry gas turbine has operated 1000 hours on coal. New types of coal feeding and ash removal equipment have been successfully developed. The ash handling equipment, of course, must take the ash out of the combustion gases before they enter the gas turbine, because otherwise they would cut the turbine blades all to pieces. This has been done with great success on the experimental turbine and a number of the other problems have been worked out.

Fuel Costs at Houma 1.61 Mills per KWH

This is a revealing account of the operation of a municipal power plant at Houma, Louisiana, producing current for a community of 18,000 population at a cost of 1.61 mills per kilowatt hour. The secret of this low power cost, of course, lies in low cost gas, but even so this is a remarkable record.

This fine record is achieved as a result of the operation of three new 2000 hp five-cylinder Nordberg gas-burning Diesel engines. These units were installed a year and a half ago when the old Diesel engines could no longer carry the load and power was purchased from the local power company at a cost of 8.32 mills per kwh. This cost for power was considered too high, so a new addition to the plant was built and the three new engines installed.

All cost and operating figures are included and there is a complete list of equipment.

More Power to Cedar Falls

This is a short but very well illustrated description of the new 5000-kw addition to the Municipal system at Cedar Falls, Iowa. This system consists of a variety of generating units, Diesels, steam turbines and hydro units. All this equipment is old, however, so this new plant was built as the first phase of a program which will ultimately result in a new plant to carry the entire load.

Designed by Stanley Engineering Co., this new plant is modern in every respect and very attractively laid out.

The Practical Engineer Section

In this magazine within a magazine we learn a lot about the lowly nail. With its many varieties and specialized uses it is our most indispensable fastener.

The symbol pH is familiar to all engineers these days but there are some who use it as a value of measurement without knowing exactly what it means. So we present this clear explanation of pH. Even if you know all about pH, this is well worth reading.

The Practical Engineer this month is filled with good solid meat for the maintenance and operating departments.

INDUSTRY'S STANDARD STEAM DRIVE!

For Continuous or Stand-by Operation...

Here's the general-purpose turbine that meets the increasingly rigid demands of modern industry. It's the Westinghouse Type E, designed to operate reliably and efficiently where the going is tough. Regardless of operating conditions, the Type E is built to give trouble-free, economical performance for long periods of continuous operation . . . or instant operation when used as a stand-by drive.

Wrapped up in one reliable unit are the best features of all Westinghouse drives . . . plus refinements and development features which are now standard on all Type E Turbines.

Weatherproof bearing seals, corrosion-resisting gland zones, centerline support for freedom of expansion and contraction, dual protection against overspeed, floating movement of governing and trip linkages, and parts interchangeability between wheel sizes are among the many advantages built into Type E drives. J-50526

WRITE FOR THIS BOOKLET. We invite your comparison . . . *on any count.* See your nearby Westinghouse representative for the full story. Ask him for Type E Turbine Book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna.

YOU CAN BE SURE.. IF IT'S
Westinghouse
TYPE E Turbines

ENGINEERS' PREVIEW

CHEMECHOL, new non-explosive device for breaking down coal, just announced by the du Pont Company. It is chemico-mechanical device designed to break coal from mine face by force of compressed gas, generated by chemical reaction in device and released mechanically.

New device consists of steel tube enclosing chemical unit. Tube is closed at one end by plug with electrical connections, at other end by rupturable disk held in place by perforated head. After tube is placed in hole drilled in coal face, chemical reaction is activated by electric current controlled within narrow limits. Heat is produced, which after a few seconds destroys the starter wire, breaking electrical circuit. Chemical reaction continues to liberate gas which builds up to predetermined pressure, at which point disk ruptures. Gases rush out through ports in head and break down coal. Tube, refilled in mine with another chemical unit unit and disk, is used repeatedly.

Chemechol produces no flame, cannot be activated by small electrical currents, such as stray currents, nor by high currents such as mine lighting or haulage circuits. Cannot be detonated by blasting caps or high strength dynamite.

★ ★ ★

SURPLUS fluorinated organic compounds from the Atomic Energy Commission's production facilities may now be bought in research quantities. Thirty such compounds, on hand in excess of needs of the atomic energy program, are available in small amounts.

Lists of the available compounds, their general properties and their cost are available from the Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation, Post Office Box P, Oak Ridge, Tennessee. Inquiries should be directed to the attention of Dr. J. D. Gibson, the announcement said.

★ ★ ★

CORNELL UNIVERSITY'S new $1,700,000 center for the study of engineering materials will bear the names of two Cornell faculty members who pioneered in engineering education.

One unit, a materials testing laboratory, will be named Thurston Hall in honor of Robert H. Thurston, who was director of Sibley College of Mechanical Engineering at the university from 1885 until his death in 1903. The other, a materials processing laboratory, will be named for Dexter S. Kimball, now in retirement at 85, who was the first dean of the College of Engineering at Cornell.

★ ★ ★

ADOPTION by the Federal Government of a uniform means of indicating paint colors culminates several years of co-operative effort by the National Bureau of Standards and the Federal Specifications Board. The new Federal Specification, better known as the Federal Color Card for Paints, reduces the more than 600 paint colors formerly used by the Government to 187, by eliminating unimportant variations of different shades. No need to belabor the importance of this both to Government and to private industry. The new color card is identified as Federal Specification TT-C-595, Colors for Ready-mixed Paints. It is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $4.50.

THE MEN AND WOMEN of a certain law office, explains *Telebriefs,* came to work one day to read this sign: "Employees who feel they *must* apply perfume to the ear, will apply it to the right and not to the left ear."

It seems that when the girls in the office used the 'phone, a delicate bouquet lingered in the earpiece. Some of the fragrance was left on the ears of the men who used the 'phone afterwards.

And as any good husband knows, it's difficult for a man to explain to his wife why his ear should smell like lilies of the valley.

★ ★ ★

AT RECENT MEETINGS in Cincinnati, during ASTM Committee Week, of Committee D-5 on Coal and Coke and three of its subcommittees there was a very well attended joint session with the Prime Mover's Committee, Power Station Chemistry Subcommittee, of the Edison Electric Institute. At that session, Subcommittee XIII on Coal Sampling considered a detailed Test Scheme which the EEI group proposes to apply to one coal, using one make of automatic sampler. The scheme is designed to eliminate the question of machine bias in sampling and to provide reliable information on variability (based on Analysis of Variance) not only in the automatically collected increments, but in hand increments of several sizes collected simultaneously by partitioning the stream on a stopped belt. The ultimate aim is to promote standards which will permit least cumbersome automatic sampling for large users of crushed or fine coal.

★ ★ ★

REMEMBER how to test a ladder? Well, you don't! We had a long discussion of this matter of testing ladders over a year ago in the Q & A Section of *Power Engineering,* the burden of which was that you inspect ladders for a great many things but you don't test them in the same sense that you test steel or other structural material. What to do correctly with ladders can be very important from the safety angle, in any plant. We are reminded of this by a recent circular from the American Ladder Institute, 666 Lake Shore Dr., Chicago 11, Ill. If you have any questions about ladders, better get in touch with this Institute, which works closely with the National Safety Council, the Forest Products Laboratory, the American Standards Association and all other bodies concerned with the subject. Don't forget that ASA has an American Standard Safety Code for Wood Ladders, A-14.1–1948. The American Ladder Institute has a recent leaflet, There's a Right Ladder for Every Job, intended primarily for dealers selling ladders but at the same time intended to familiarize users of ladders with vital facts about them.

★ ★ ★

U. S. SUPREME COURT, on April 9, 1951, upheld the validity of the Ohio River Valley Water Sanitation Compact and gave the Valley a legal basis for its assigned job of cleaning up the Ohio River. For an authoritative discussion of all the factors involved in the water pollution (also the air pollution) problems of Ohio, take a look at the April 1951 issue of the *Engineering Experiment Station News,* published by the Ohio State University, Columbus, Ohio.

THIRTY-NINE TOP-LEVEL coal and railroad executives have been invited to serve on a BCR Plan-of-Action Committee, charged with the responsibility of formulating a program of research and related activities that will satisfy the needs of coal consumers and increase coal markets, according to Dr. A. A. Potter, president of Bituminous Coal Research, Inc.

The new committee has been formed (1) to evaluate the research and engineering needs of the industry as soon as possible, (2) to recommend an effective program of such activities for accelerated industry progress, and (3) to obtain industry consideration of the plan at an early date. The ultimate objective is an adequate, balanced program of research, engineering, and promotion of results that will bridge the gap between research reports and the practical application of technical advancements by coal and railroad companies and coal users.

★ ★ ★

A PASSENGER traveling a rickety local across the Indiana plains realized the train was picking up speed as it neared the sprawling Chicago outskirts. In fact, as he bounced around watching the scenery fly by, he decided the engineer must have gone crazy, and called the conductor for confirmation.

"Naw, he's just enjoying himself," said the skipper. "See that Diesel streamliner running even with us on that parallel track?"

"Yes, but what's that got to do with it?"

"Well, sir, our head-end crew just plumb despises them Diesels. So whenever we come in about time that streamliner does, the hogger yanks out the throttle and the fireman pours on the coal till we get even with her. Then just as we come into the station, the fireman reaches out with his long clinker bar and hangs on the front end of that Diesel as if we were towing 'er in.

"We ain't crazy, mister, but believe me, them boys on the streamliner are rapidly gettin' that way!" — *C & O "Tracks"* via *Smoke Abatement Review.*

★ ★ ★

BOND between silicone rubber and metals or ceramics that is stronger than the rubber itself results from a new chemical development made by General Electric's Chemical Department at Pittsfield.

Designated as G-E 81267 primer, this new development is a thin, light-colored liquid. But using it, G-E silicone rubber 81223 can be bonded to almost any surface. Bonds to glass, ceramics, aluminum, steel, tin and copper are possible, and sheer strength measurements of bonds on steel are approximately 700 psi.

The development of G-E 81267 primer now makes possible a wide variety of silicone rubber-to-metal molded products which include shock and engine mounts that resist both high and low temperatures. Also, improved rubber-glass laminated structures are now possible, and G.E.'s new high-strength silicone rubber in conjunction with G-E 81267 primer can be used as an adhesive with unusual new properties.

★ ★ ★

MOBILIZATION GUIDE for Small Business has just been issued by the Defense Production Administration. It discusses defense contracts and procurement, civilian production, financing, production and facility control methods, management assistance, publications and gives a list of regional and field offices. Get a copy from the Office of Small Business, National Production Authority, U. S. Department of Commerce, Washington 25, D. C.

NEW "YARDSTICK," which uses different colors to measure millionth-of-an-inch thicknesses, was described recently in Cleveland by one of America's foremost woman scientists.

Speaking at the 119th national meeting of the American Chemical Society, Dr. Katharine B. Blodgett, of the General Electric Research Laboratory at Schenectady, called the new tool a "stepgage," and said it is used to measure thicknesses of materials occurring in the form of extremely-thin films. An example of such films would be an ordinary soap bubble of the type that reflects iridescent colors.

According to Dr. Blodgett, the stepgage she developed is used like a yardstick, but in place of linear divisions are blocks of different colors, each of which, like the steps of a staircase, is higher than the one next to it. These blocks of color are mounted on a length of glass in the shape of a measuring rule.

In films of a few millionths of an inch thick, colors vary with changes in thickness, so that a particular color indicates a particular thickness.

In using the stepgage, the color of a film of unknown thickness is matched to that block of color on the stepgage, which is the same or similar. A thickness reading, marked underneath that particular block of color on the stepgage, indicates the thickness of the unknown film.

Color blocks on the stepgage she demonstrated at the meeting run from one-millionth-of-an-inch thick to 30 millionths, although gages with wider ranges can be made.

★ ★ ★

NEW, THIN ELECTRICAL STEEL with unusual properties has been developed. Known as TRAN-COR T-O-S, it can be operated at very high inductions, 20 per cent higher than any nickel-iron alloy.

The new material, thinner than most electrical steels, is intended for use in wound-type transformers and reactors which operate at 400 cycles. It was developed under a contract with the Bureau of Aeronautics of the Navy Department to permit the miniaturization and reduction in weight of airborne electrical equipment.

The new steel is an iron-silicon alloy with a high degree of orientation obtained by special processing and test-selection for high permeability requirements. It has a density of 7.65 grams per cu cm, a volume resistivity of 47 microhm-cm or 282 ohms per mil ft and a lamination factor of 95 per cent solid.

TRAN-COR T-O-S is supplied in only 4-mil thicknesses and in 12⅜ in. wide coils. It is surface treated on both sides by a special chemical and thermal processing, to insure low interlaminar energy losses. The surface treatment is unaffected by annealing.

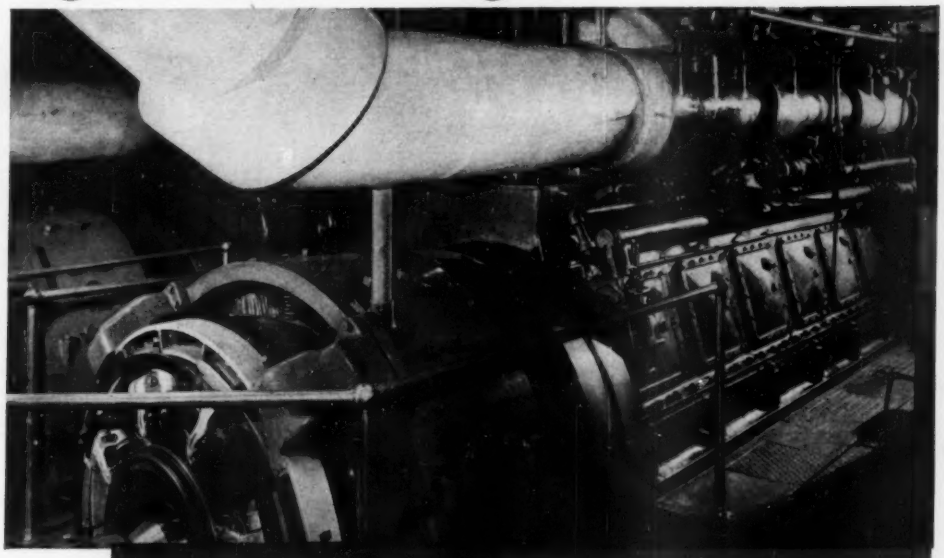
★ ★ ★

OPEN HEARTH SLAG, formerly dumped onto waste land in the vicinity of steel plants, is now prepared for use as part of the flux burden of blast furnaces.

That use of open hearth slag not only decreases the amount of new limestone used but recovers valuable amounts of iron and manganese. However, this use is limited.

The material, properly sized, goes to the blast furnace to replace approximately 10 per cent of the flux burdens. Slag emerging from the blast furnace contains only about one-half of one per cent iron and a little less than 2 per cent manganese. Considering the weights of the elements iron and manganese entering and emerging from the blast furnace, it is evident that worthwhile amounts of both iron and manganese are recovered.

Sing a song of savings



Lubricate with TEXACO URSA OILS

Your engines—Diesel, gas or dual-fuel—will really hum when you lubricate with *Texaco Ursa Oils*. And *you'll* sing their praises when you see how these famous oils resist oxidation . . . assure clean engines, free rings, open ports and properly functioning valves . . . real harmony.

Texaco Ursa Oils thus assure better compression and combustion, smoother operation, minimum wear. Bearings and all moving parts last longer . . . maintenance costs and fuel consumption go down. Change your tune . . . switch to *Texaco Ursa Oils* for stepped-up efficiency and economy.

Texaco Diesel lubricating oils are available in every needed viscosity, and there is a complete line of them approved by leading engine builders. They are No. 1 in popularity from coast to coast! For example, in the Diesel field:

More stationary Diesel h.p. and more railroad Diesel locomotives in the U.S. are lubricated with Texaco than with any other brand.

Let a Texaco Lubrication Engineer direct you to greater savings throughout your plant. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO URSA OILS

FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

Boiler Water Indication

AT THE BOILER DRUM
YARWAY FLOATLESS HI-LO ALARM WATER COLUMN with VERTICAL PRESSURE-SEALED FLAT GLASS GAGES. Glass gages have patented "floating assembly" that reduces glass breakage and leakage. See Bulletin WG-1811.
YARWAY
H
L

YARWAY

ON THE LEVEL with a Yarway System

It's accurate! It's where you can see it!

These two most important needs for boiler water level indication are assured with a Yarway system.

Yarway indicating equipment is accurate because it is *operated directly by the boiler water itself.* Yarway Weight-operated Hi-Lo Alarm Water Columns with either Secure Inclined or Flat Glass Vertical Gages take care of the job at the boiler drum. On the instrument panel or other desired location, Yarway Remote Liquid Level Indicators bring overhead gage readings down to convenient, easy eye-level vision. By use of a Control Unit on the indicator, additional Hi-Lo light or sound alarms can be located at any place in the plant.

The Yarway HI-LO-GRAPH, a panel-mounted *recording* indicator, gives a 24-hour record of boiler water levels.

Yarway engineers will gladly show you how the Yarway Boiler Water Indicating System increases power plant *safety* and *efficiency.*

For the full story on Yarway Indicators, write for a free copy of Yarway Bulletin WG-1822.

YARNALL-WARING COMPANY, 114 Mermaid Avenue, Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

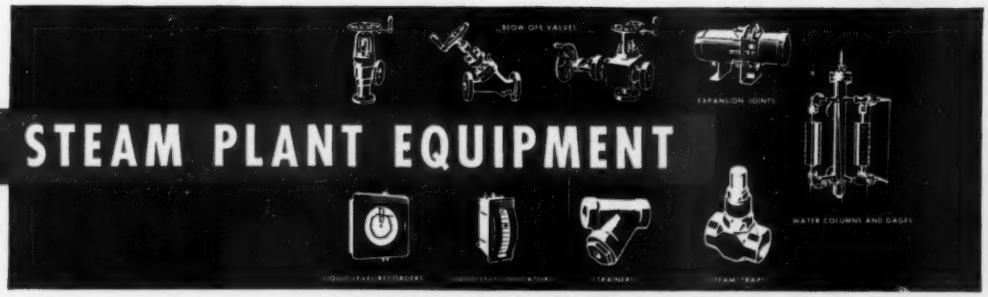
ON THE INSTRUMENT PANEL

YARWAY REMOTE LIQUID LEVEL INDICATOR, operated directly by the boiler water itself, by the pressure differential between a constant head and the varying head in the boiler drum. Indicating mechanism is never under pressure—no stuffing boxes. See Bulletin WG-1822.

YARWAY HI-LO-GRAPH RECORDER provides not only instant indication but also 24-hour recording of boiler water levels. See Bulletin WG-1824.

ANYWHERE IN THE PLANT

YARWAY REMOTE HI-LO ALARM SIGNALS, lights or horns. Operated by Control Unit attached to Remote Liquid Level Indicator or Recorder. Any number can be installed, at any desired locations throughout the plant. See Bulletin WG-1822.



ONE VU LEADS TO ANOTHER

When VU Boilers were first put on the market, *all* of them, quite naturally, had to be *sold*. Now a very substantial percentage are *bought*. Bought by companies that know by their own first-hand experience what they can expect in day-in and day-out performance—for example:

A paper company some years ago, in urgent need of more capacity, purchased a VU Unit. It went on the line, and—under wartime demand—*stayed there* for 432 days without a shutdown. What do you think they bought when next in the market in 1946? That's right . . . another VU (much bigger than the first).

An automobile company installed its first VU Units (2) in 1947. Two more were ordered for another of its plants in 1948; then three more units for a third plant in 1949 and two more for still another plant in 1950.

A refinery ordered its first VU Unit in 1937. In 1941 another was installed and still another in 1950. For another of its plants two units were ordered in 1942 and a third in 1947.

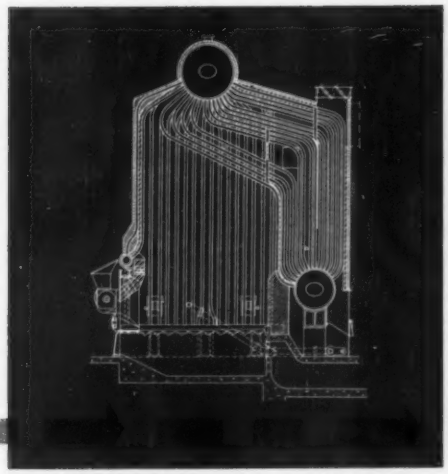
An electric utility company installed its first VU Unit in 1941. Two more units were ordered for another of its plants in 1947, a unit for a third plant in 1946 and still another for a fourth station in 1949.

* * *

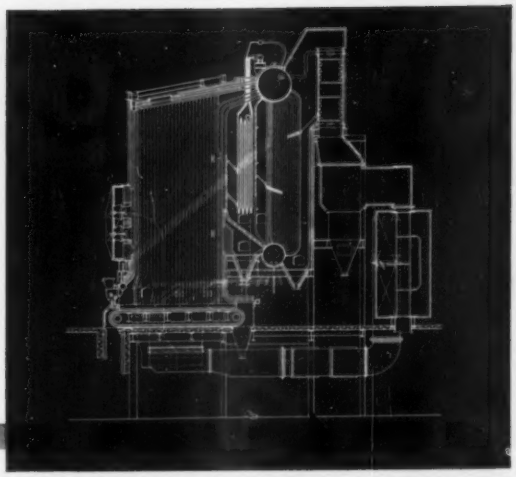
And so it goes – in all sections of the country – and abroad – industry after industry ordering and *reordering* VU Boilers. There must be a reason—and there is. The VU's advanced design, rugged construction and consistent reliability have become a service-proved answer to lower steam costs. You can choose VU with confidence based on the experience of companies in *your* industry, in *your* area. B-485

COMBUSTION ENGINEERING

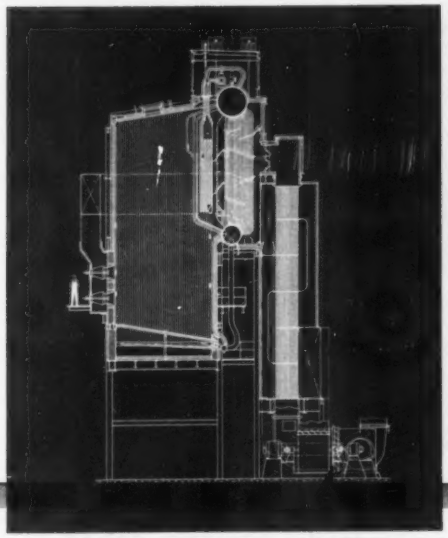
ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



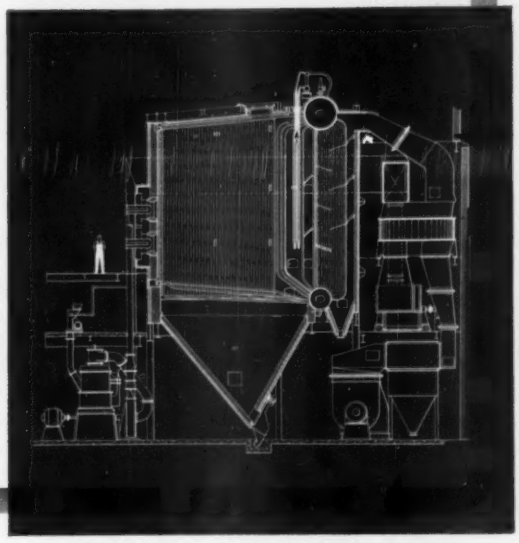
VU-10 Unit fired with C-E Spreader Stoker (dumping grate type). VU-10 Boilers range in capacity from 10,000 to 60,000 lb of steam per hr. May also be fired by underfeed or traveling grate stokers, or by oil or gas.



VU-50 Unit fired with C-E Spreader Stoker (continuous discharge type); auxiliary gas and oil burners in upper front wall. Capacity of unit shown is 90,000 lb steam per hr; operating pressure—650 psi; steam temperature—825F.



VU-50 Unit fired with natural gas or oil. Design provides for future pulverized coal firing. Capacity of unit shown is 350,000 lb of steam per hr; operating press.—920 psi; steam temp.—905F.



VU-50 Unit fired with pulverized coal using C-E Raymond Bowl Mills. The capacity of unit shown is 150,000 lb of steam per hr; operating pressure—600 psi; steam temperature—700F.

— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

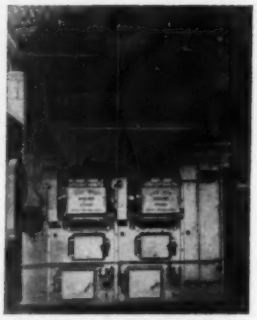
C-E

A LOW HEADROOM BOILER

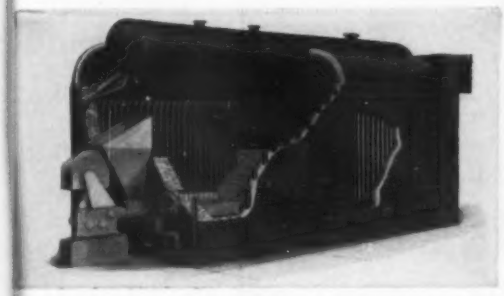
That can take it

THIS compact, low headroom 2 drum water tube boiler features extra large water and steam capacity. Side wall water cooling reduces refractory maintenance to the vanishing point even at maximum ratings. As illustrated here the VL is well adapted to all firing methods. The VL's all steel casing and trim appearance makes any boiler room a showroom. It is recommended for sizes to 750 HP and is furnished as a completely shop assembled unit in sizes to 300 HP and larger depending upon railroad clearances.

250 HP Erie City VL-Boiler oil fired at a western New York dry cleaning plant.



160 HP Erie City VL-Boiler fired by Erie City Spreader Stoker in an Ohio automobile manufacturing plant.



Outstanding of many VL features is the ring-flow circulation in each side wall element. A downcomer tube for each pair of radiant (riser) tubes in the side wall with auxiliary front wall downcomers assure an ample supply of clean circulating water in the walls at all times. Tile between riser and downcomer tubes assures rapid and unrestricted circulation.

200 HP Erie City VL-Boiler fired by Erie City Underfeed Stoker in a western paper products plant.

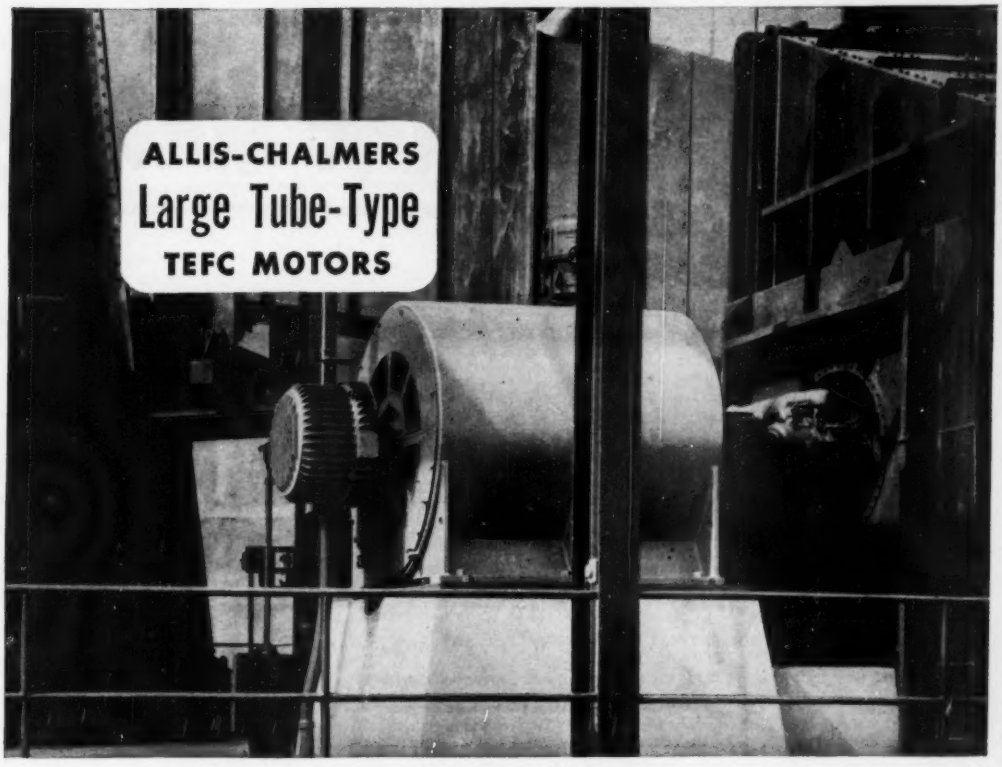
FOR COMPLETE DATA
***write for* BULLETIN SB24B**

COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

Complete Steam Generators • Type C 3-Drum Boilers • Types VL & VC 2-Drum Boilers • "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • "Keystone" Packaged Steam Generators • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

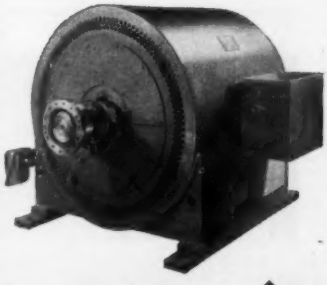
ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*



170,000 Hp Already Purchased

IN SIZES FROM 250 THROUGH 2500 HP

For really tough motor installations, central station engineers are turning to Allis-Chalmers large *tube-type* motors to get the peak reliability they know they need. Already over 170,000 hp of these totally-enclosed fan-cooled motors have been purchased. And practically 50% of the orders now are *reorders* from satisfied users.



Advantages offered by the *tube-type* air-to-air heat exchanger design of these motors include:

1. Full internal air circulation—for efficient, even cooling—makes large ratings practical.
2. Complete enclosure — protects stator core and other electrical parts from corrosive conditions.
3. Self-cleaning action — results from generous flow of outside air through smooth, straight cooling tubes.

For more information about these operation-proved TEFC motors, contact your Allis-Chalmers representative, or write for new bulletin 05B7150A. Allis-Chalmers, Milwaukee 1, Wisconsin. A-3416

ALLIS-CHALMERS

It Gives You the Torque

Edward Valve IMPACTOR HANDWHEELS

GIVE YOU FROM 2.8 TO OVER 12 TIMES THE FORCE OF AN ORDINARY HANDWHEEL TO CLOSE VALVES

It takes three strong men, pulling their hardest, on an ordinary valve handwheel to equal the closing force of ONE man using an Edward 16" Impactor Handwheel. With progressively larger size Edward Impactor Handwheels, the force available to close a valve is equal to six, eight, ten and, yes, *even twelve men.*

Originated and patented by Edward and improved through the years, the Impactor handwheel is the one most effective means of manually closing a valve so it is absolutely tight against high operating or test pressures in power, petroleum, chemical, marine, or industrial plants. It needs no clumsy expensive gear or toggle construction, or the use of extension levers or cinch bars for actuating.

Its space-saving design allows piping designers great latitude in locating valves, walkways and operating platforms.

But most important, the Edward Impactor handwheel means sure, fast operation of valves—big or little—in an emergency or under normal operating conditions by a single man. It saves manpower by giving ONE man more power. NOW standard equipment on most 900, 1500 and 2500 lb Edward Valves, 2½ inches and up.

The Impactor principle is simple. Two heavy lugs are cast on the underside of the wheel: a sharp turn of the wheel causes these lugs to strike simultaneous blows against a steel cross arm, locked to the stem or revolving EVaithrust yoke bushing. Write for full facts, Edward Valves, Inc. 220 West 145th Street, East Chicago, Indiana.

WOMANPOWER BEATS MANPOWER!

Many smaller size Edward valves are available with the new Impactor Handle (right in photo) for greatest closing efficiency. Design principle is same as Impactor handwheel, and test gages prove it too gives you the torque of six hands or 2.8 times the closing force of an ordinary handwheel. You know the valve is closed absolutely tight with an Edward Impactor Handle.

FEATURES LIKE THIS SAVE YOU MONEY AND WORK....
That's why it pays to specify Edward Valves.

# of SIX Hands and More

ORIGINATED BY EDWARD
"BIRTHPLACE OF BETTER
VALVE DESIGNS"

Another Product

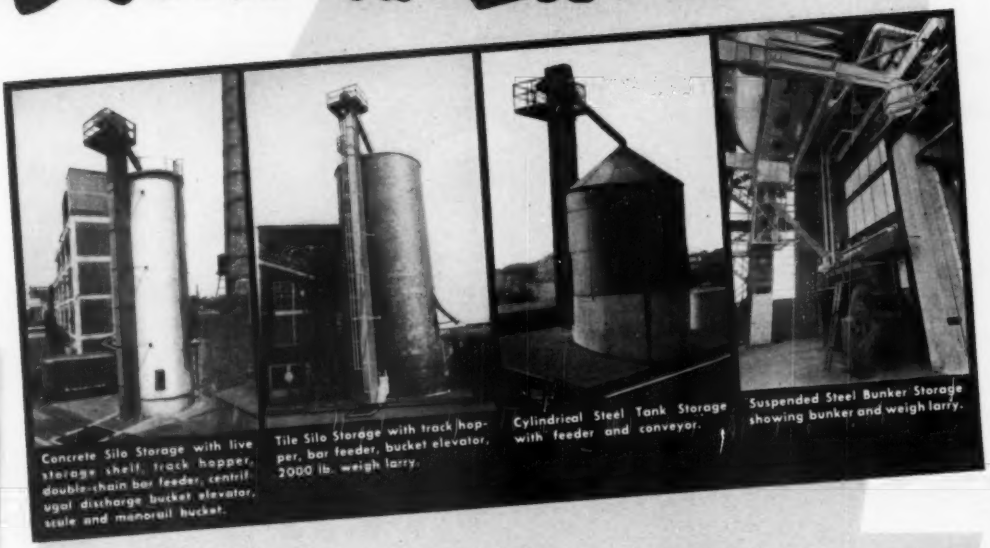
Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

BRINGING YOUR COAL HANDLING COSTS

Down to Earth



Concrete Silo Storage with live storage shelf, track hopper, double-chain bar feeder, centrifugal discharge bucket elevator, scale and monorail bucket.

Tile Silo Storage with track hopper, bar feeder, bucket elevator, 2000 lb. weigh larry.

Cylindrical Steel Tank Storage with feeder and conveyor.

Suspended Steel Bunker Storage showing bunker and weigh larry.

When coal handling costs are too high for comfort, remember Gifford-Wood's 4-basic design story. Each of these storage designs—concrete silo, tile silo, cylindrical steel tank and suspended steel bunker—are carefully engineered to meet specific limitations of climate, capacity, space available and cost. The combination of extensive engineering experience and well known manufacturing ability assures installations of highest possible operating efficiency at reasonable cost.

A Gifford-Wood engineer, thoroughly familiar with coal handling problems, is at your service. Let him study your needs and recommend a G-W system that will both simplify the operation and reduce your costs.

4

BASIC G-W WAYS TO CUT COAL HANDLING COSTS

1. Reinforced Concrete Silo Storage
2. Vitrified Tile Silo Storage
3. Cylindrical Steel Tank Storage
4. Suspended Steel Bunker Storage

Bulletin No. 300 describes, with illustration and working drawing, these 4 basic G-W types of handling systems. Write today for your copy.

GIFFORD-WOOD CO.

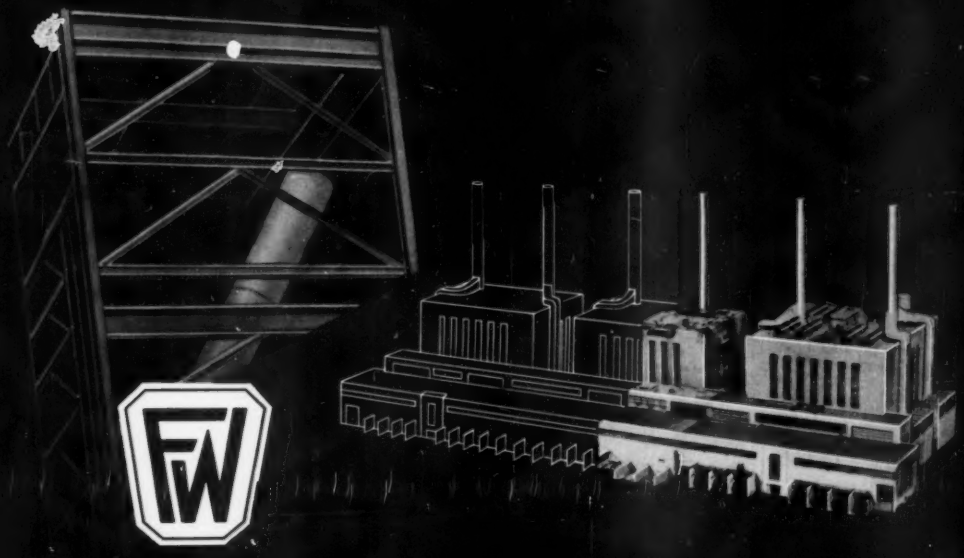
SINCE 1814
Hudson, N. Y.

NEW YORK 17 — 420 LEXINGTON AVENUE
CHICAGO 6 — 565 W. WASHINGTON STREET
ST. LOUIS 1 — RAILWAY EXCHANGE BUILDING

CD 6578

G-W HANDLES IT . . . faster • easier • cheaper

the **FUTURE**... an extension of the present

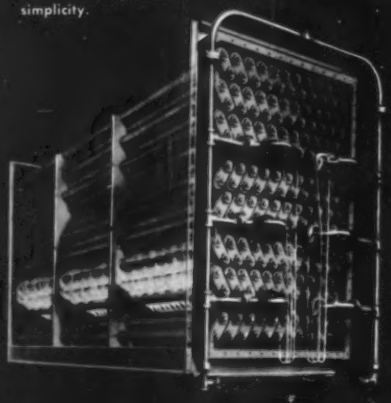


STEAM GENERATORS for every industry designed, engineered and built to meet existing and anticipated needs of a growing economy.

AUXILIARY STEAM GENERATING EQUIPMENT . . .

ECONOMIZERS

The Foster Wheeler cast-iron, extended surface, steel tube Economizer can be depended on for superior service because it is (1) corrosion resistant, (2) impervious to soot fires, (3) cleanable, and (4) unique in its simplicity.



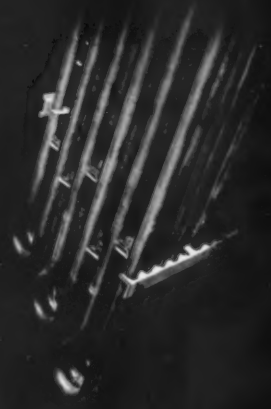
REHEATERS

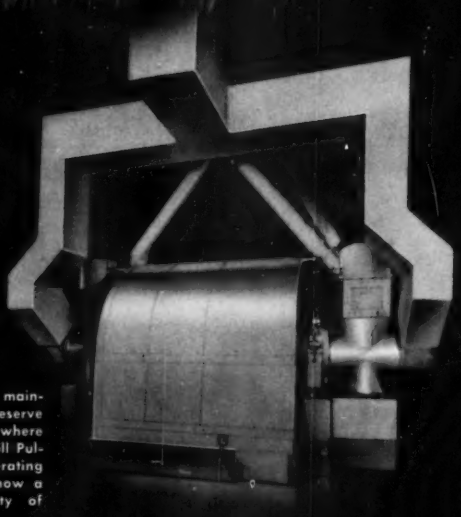
Over the past several years increased emphasis has been placed on Reheat as a means toward better station heat rate. Foster Wheeler experience in the design and fabrication of Reheaters may be measured partly by the consistently successful operation of one of the world's most efficient power stations where Foster Wheeler Radiant Reheaters and Radiant Superheaters are installed.

TUBULAR AIR HEATERS, WATER WALLS, MULTI-FUEL BURNERS, WASTE HEAT BOILERS

SUPERHEATERS

Foster Wheeler, first to develop the use of superheated steam in this country, designs, engineers, and fabricates convection and radiant type superheaters singly or in combination. SUPERHEAT CONTROL over a wide load range is also offered as a means of positive and accurate control of final temperature.

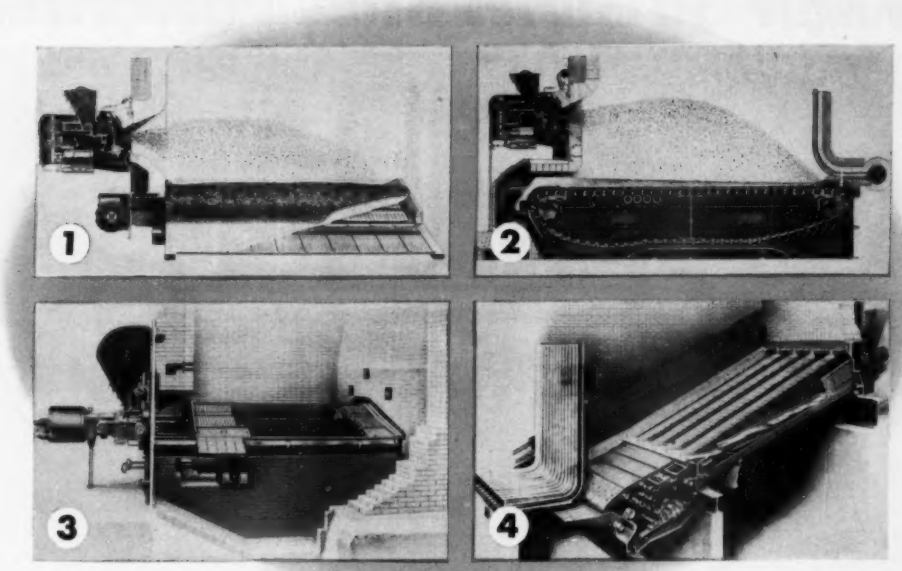




PULVERIZERS

High availability, low maintenance, and large reserve capacity are assured where Foster Wheeler Ball Mill Pulverizers are used. Operating records consistently show a remarkable availability of 99% or better.

FOSTER WHEELER CORPORATION · 165 BROADWAY, NEW YORK 6, N. Y.



High Efficiency...Ease of Operation

in the Stoker Type That Meets Your Need

1. *Centrafire with Link-Grate*

The Centrafire with Link-Grate is a unique spreader-type stoker for medium capacities to upward of 50,000 pounds of steam per hour. Fuel feed is continuous. Link-Grates move the burning fuel toward the side walls. Refuse is discharged without reducing load or losing steam pressure.

2. *Centrafire with Traveling Grate*

A spreader-type stoker with traveling grate for the larger Central Station and industrial plant. Maximum capacity upward of 350,000 pounds of steam per hour. Same fuel feeding and distributing mechanism as Centrafire with Link-Grate. Forward-moving traveling grate for continuous discharge of ash.

3. *Link-Grate Single-Retort Stoker*

The Link-Grate Single-Retort Underfeed Stoker is an economical means of burning many coals for the small installation. Link-Grate motion maintains an active, porous fuel bed for efficient coal burning with a minimum of attention.

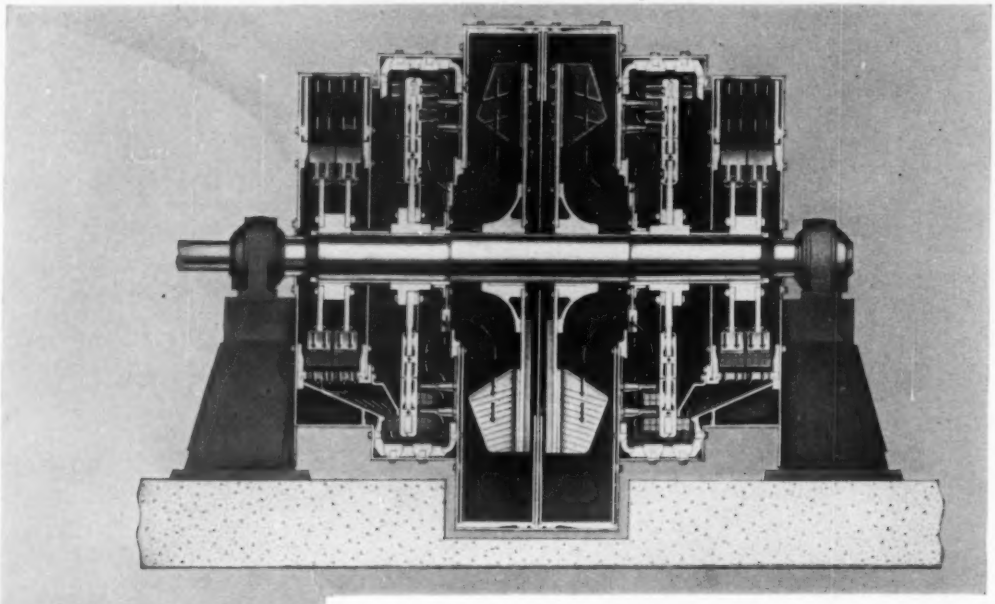
4. *Link-Grate Multiple-Retort Stoker*

A clean stack and outstanding efficiency are characteristic of the Link-Grate Multiple-Retort Underfeed Stoker for the larger installation where fuel is suited to underfeed type firing. Link-Grate motion and continuous ash discharge permit heavy, continuous loads.

Call your nearby Westinghouse office or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa., for complete information. J-50523

YOU CAN BE SURE... IF IT'S
Westinghouse
STOKERS

The NEW "50" Series Riley Pulverizer

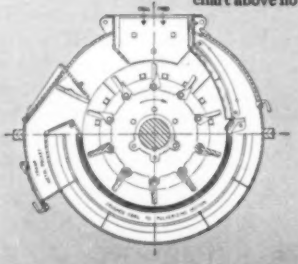


Pulverizing parts faced with Tungsten Carbide

Long periods continuous operation
Low maintenance . . . Sustained fineness

Development of the use of tungsten carbide faced pulverizer parts was started by Riley over ten years ago. Hundreds of existing Riley pulverizers have been equipped. The use of tungsten carbide adds tremendously to the life of the parts. While Riley pulverizers have been in operation for over two years and have pulverized in excess of 50,000 tons of coal, wear of the tungsten carbide is scarcely measurable. These parts are good for many more years of service.

The use of tungsten carbide not only assures long continuous periods of operation without maintenance shutdowns, but because of the extremely long life, greatly reduces maintenance cost per ton of coal pulverized. Fineness of pulverization is sustained without any adjustments whatsoever. You will note from the chart above no reduction in fineness though practically 50,000 tons of coal have been pulverized.



Preliminary Crusher-Dryer Section

No capacity reduction with high moisture coals
Complete reliability

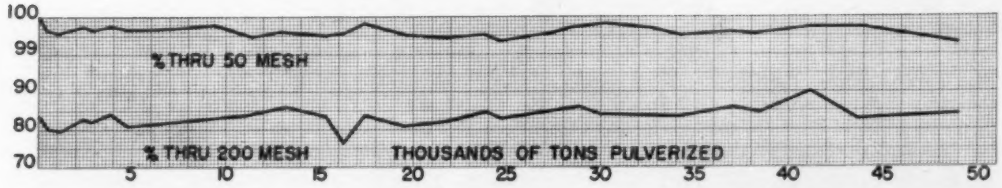
Provided air or furnace gas of sufficient temperature is supplied, there is no capacity reduction with increased moisture content of the coal. The crusher section acts as a flash dryer. In this section coal is crushed to a fine granular state, approximately 40% through a 50-mesh screen, representing about 5% of the work to be done. Coal enters the pulverizing section where 95% of the work is done, with free moisture evaporated from the coal, consequently moisture content of the coal entering the crusher section has no effect on pulverizer capacity.

The crusher section of the pulverizer rejects tramp iron, iron pyrites and other hard foreign substance in the coal, preventing any materials from entering the pulverizer section which could cause damage.

RILEY STOKER CORPORATION
WORCESTER, MASS.

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • FLUE GAS SCRUBBERS

a most significant Pulverizer Development



Other Operating Advantages

in addition to long life, low maintenance, sustained fineness of pulverization . . . no capacity reduction with high moisture coals and complete reliability

Here is what one user has to say about his Riley pulverizers after equipping them with tungsten carbide parts:

Pleased to advise that in my opinion Riley Mills with carbide elements will outperform any mill today. Original parts installed Sept. 1948 are still going strong and fineness does not go below 80% through 200 mesh. Fully expect mill maintenance cost will run less than three cents per ton.

Flexibility—Wide Load Range
As change in coal feed gives instantaneous corresponding change in pulverized coal output—there is no lag—rapidly and widely fluctuating loads are efficiently and easily carried.

Ability to Carry Low Loads
With the combination of Riley pulverizers and burners, extremely low loads with stable ignition can be maintained. It is not unusual for load ranges of 10 to 1 or for loads under 5000 pounds of steam per hour to be carried at Riley installations.

High Primary Air Temperatures
There is no necessity of limiting primary air temperatures as a precaution against fire or explosion or because of lubricating problems. Expensive control equipment limiting primary air temperatures is not required.

Ease of Lighting
Because of small percentage of primary air, a rich and readily lighted mixture of air and coal is obtained which together with the uniform distribution with Riley burners makes lighting easy and gives stable flame at low loads.

Quiet, Vibrationless Operation
There is no comparison between Riley pulverizers and other makes insofar as quiet vibrationless operation is concerned. You hear nothing more than a motor hum.

Small Space Required—Minimum Foundations
Riley pulverizers require less space per unit of capacity. Massive deep foundations are not required due to their vibrationless quiet operation.

Explosion Proof
There has never been an explosion in a Riley pulverizer. The velocity of coal travel through the pulverizer is faster than the rate of flame propagation, eliminating the possibility of an explosion.

These companies have recently ordered new "50" Series Riley Pulverizers

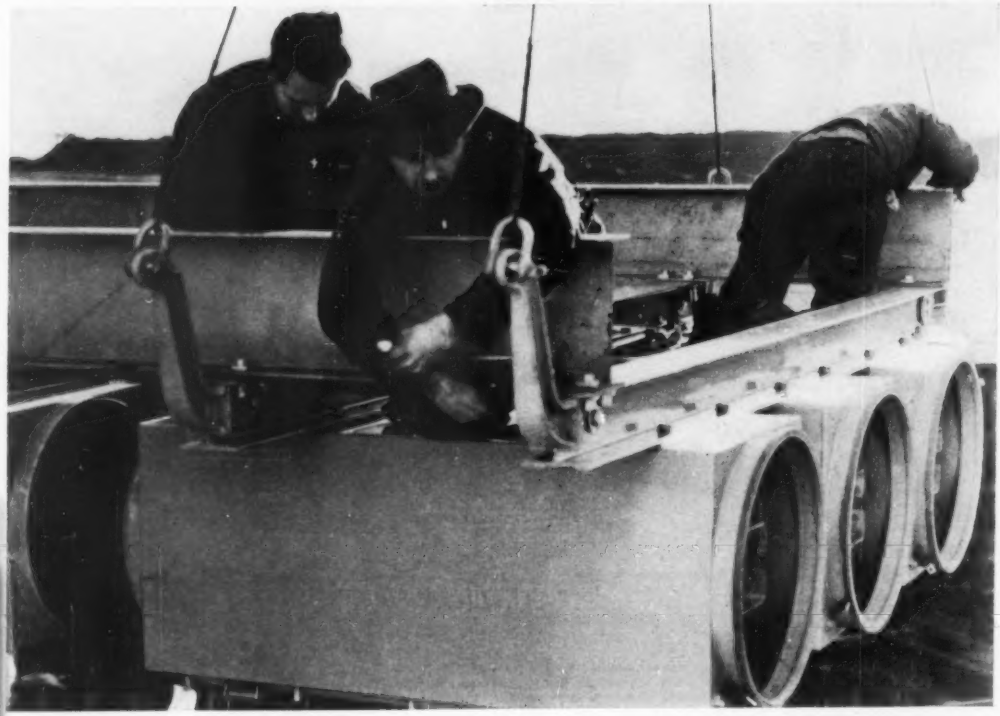
Monongahela Power Company
Albright, W. Va.
Iowa-Illinois Gas & Electric Co.
Davenport, Iowa
Utah Power & Light Co.
Salt Lake City, Utah
Superior Water, Light & Power Co.
Superior, Wisc.
Western Electric Co.
Chicago, Ill.
Carnegie Illinois Steel Co.
Youngstown, Ohio
Celanese Corp. of America
Rock Hill, S. C.
Pittsburgh Plate Glass Co.
New Martinsville, W. Va.
Hooker Electrochemical Co.
Niagara Falls, N. Y.
U. S. Finishing Co.
Norwich, Conn.
Syracuse University
Syracuse, N. Y.
Riegel Textile Corp.
Trion, Ga.
City of Austin
Austin, Minn.
Ciba States Ltd.
Toms River, N. J.
Bell Aircraft Corp.
Niagara Falls, N. Y.
Potomac Light and Power Co.
Albright, West Va.
Northern Paper Mills
Green Bay, Wisc.

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS

Remove crate . . . Lift into place

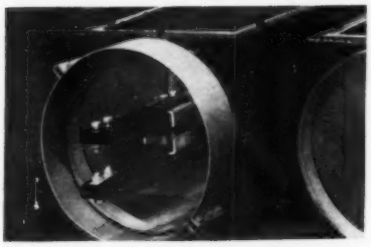


ISOLATED-PHASE BUS SECTIONS shipped assembled, ready to install

Factory-assembled G-E isolated-phase bus sections pay off in low installation costs. Crated three-phase sections arrive ready to lift into place. You simply knock sides off crate—apply lifting brackets to "H" mounting beams and hoist into position for permanent bolting. When bus connections are made with semi-flexible connectors and sectional joints are sealed with gasketed banding rings—the job is complete!

Other advantages of G-E design include high insulation values—reduced number of creepage surfaces without sacrifice of mechanical strength—dust and water-tight hinged covers which open from either side for easy inspection.

Your G-E sales representative has complete information. Ask him for a copy of GEA-5460, a 28-page publication that will aid you in planning your buses, or write to General Electric, Schenectady 5, N.Y.



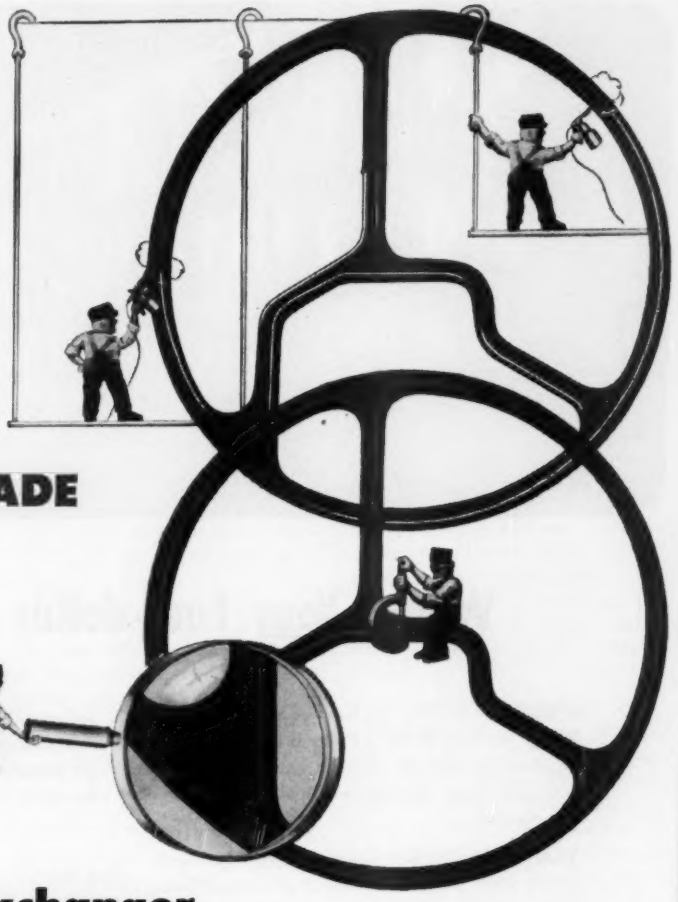
Semi-flexible connectors join copper buses of adjacent sections. This provides quick and easy alignment between sections. Split gasketed aluminum banding rings seal out dust and water, reduce maintenance.

855-29

GENERAL ELECTRIC

PAINTED

to resist rust...



PRECISION-MADE

to resist blowouts...

...this Heat Exchanger Gasket will stay on the job longer

The durable coating of red paint on every Goetze iron or steel-jacketed Style 923 Heat Exchanger Gasket is a sure "stop light" against rust. And rust, as every metal gasket user knows, is a primary cause of deterioration—both in the storehouse and on the job awaiting installation.

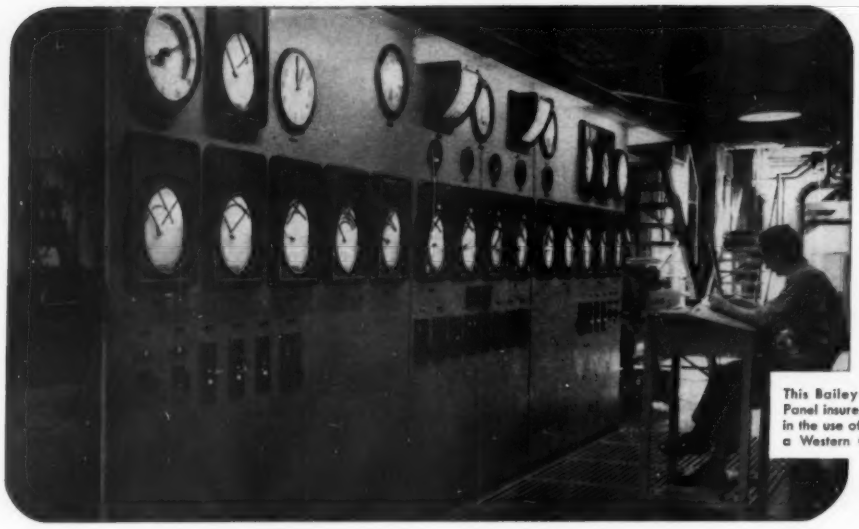
Equally important in the fabrication of Style 923 is the precision craftsmanship which eliminates cracks and wrinkles in the metal jacket—defects which can rapidly lead to leaks and blowouts.

"Custom tailoring" accounts for the meticulous care which is taken in the forming of every one of these gaskets... care which results in a long, efficient service life. You can always depend on a Goetze Style 923 to fit and seal perfectly... to stay on the job without leaks or blowouts. And that, of course, pays off in less down time and fewer gasket replacements.

Find out how little it costs to have Goetze Heat Exchanger Gaskets "tailored" to the size and shape *you* need. For prompt estimates and recommendations, write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville Goetze GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE.



This Bailey Boiler Control Panel insures high efficiency in the use of Fuel-Dollars at a Western Chemical Plant.

What's Your Fuel-dollar Efficiency?

A dollar's worth of fuel has the *same potential* energy, no matter who's boiler it fires. But how much of the energy actually gets converted to a usable form depends on how you operate your boiler.

That's where Bailey Controls can help. And, here's why, we believe, you'll get better fuel-dollar efficiency with Bailey:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's Sales-Service Engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better fuel-dollar efficiency—for more power per fuel-dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-109-1

BAILEY METERS

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION
COPPER ALLOY BULLETIN
"Bridgeport" BRASS CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Dezincification Can Be Retarded

It is clearly evident that certain deposits of either corrosion products or porous materials may set up corrosion cells which initiate dezincification in brass. Therefore, whatever steps can be taken to prevent such deposits from attaching themselves to the metal surface will help reduce dezincification. It should be recognized from the outset that these porous deposits do not need to be any larger in diameter than the point of a pin.

At least five methods have been used to retard dezincification; namely—

1. Mechanical cleaning.
2. Chemical cleaning.
3. High velocity or turbulent flow.
4. Formation of protective coatings.
5. Use of inhibited alloys—arsenical admiralty or arsenical aluminum brass.

Effect of Silt

Muntz metal, non-inhibited Admiralty and non-inhibited aluminum brass condenser tubing, kept clean by the scouring action of small amounts of sand and certain types of fine silt entrained in the circulating water, or by chlorination and frequent brushing, have corroded at low rates (generally .001 ipy or less).

Yellow brass and Muntz metal piping and tubing kept free from various deposits have given very long service.

Effect of Turbulence

The high degree of turbulence found at the entrance end of brass condenser tubes has been observed as being very effective in preventing dezincification for a distance of a few inches up to two feet. Under very turbulent conditions dezincification has virtually been completely prevented along the entire length of such tubes. Where the turbulent condition exists at the entrance end only, non-inhibited brass alloys may be subject to slow attack about .022 ipy along the remainder of the tube length. However, it must be remembered that high turbulence is often associated with impingement corrosion. Here impingement - resistant alloys such as aluminum brass, aluminum bronze and cupro nickel serve best.

It has also been observed that propellers cast from high strength brasses, which have been in constant service in sea water for many years, have shown virtually no dezincification although there may be some evidence of erosion and cavitation. On the other hand, propellers idle for some time may be subject to rapid dezincification.

Effect of Protective Scales

Certain waters which have deposited magnesium silicate or silica scales or coatings on brass surfaces are without effect on the brass. Under such conditions these silica or silicate scales are completely protective to the underlying metal and the alloy may last indefinitely. Dense adherent calcium carbonate scales are also effective in reducing or preventing dezincification but if too thick they will cut down the heat transfer rate.

Non-Scaling Waters Are Corrosive

Dezincification is most likely to occur in non-scale forming fresh or salt waters. In many instances, difficulty from dezincification in susceptible brasses is unknown until such time as a scale forming water is softened. Then it becomes necessary to use those copper-base alloys which are resistant to dezincification such as red brass, inhibited yellow brasses, arsenical Muntz, Admiralty or aluminum brass. The other alternative is to hold the mineral balance in the water at such a level that it will be slightly scale-forming.

It has been clearly demonstrated over a period of years that the greatest difficulty due to dezincification in non-inhibited yellow brasses has occurred in non-scale forming waters. For the most part such waters have a calcium carbonate saturation index of from minus 0.5 up to minus 3.5. This is usually characteristic of a water having a low total solids and calcium content and an appreciable amount of bicarbonate.

Effect of pH Values

Dezincification can occur in fresh and salt waters with the pH ranging from 5.0 to 8.0 or higher. The pH value in itself is not particularly significant. It can, however, become very important where adjustment in the pH may lead to mineral scale formation or the dissolving of mineral scales.

Non-scale forming waters, such as a solution of sodium chloride, will lead to dezincification in a non-inhibited yellow brass in the presence of deposits at any pH value, ranging from pH 1.0 up to a pH of 12. In such media, however, the tendency of plug-type dezincification is more marked in the higher pH range and the tendency for general dezincification is greater in the lower pH range, with a rather broad twilight zone in the central section of the pH scale. This is evidently due to the solubility of the zinc corrosion products in solutions having either a very low or a very high pH value.

At this point, it is of interest to note that sea water having a pH of 8.0 leads to general dezincification of uninhibited Muntz metal at a rate of about .009 ipy. (6830)

DURANICKEL

A wrought, age-hardenable, corrosion-resisting alloy

Duranickel® is a wrought, non-ferrous, slightly magnetic alloy. It has the higher strength found only in the heat-treated alloy steels, and not offered by other corrosion-resisting alloys available at comparable cost levels.

The principal engineering characteristics of Duranickel are:

● **Mechanical Properties:** The accompanying table shows the ranges of Ultimate Tensile Strength, Yield Strength, Elongation, and Hardness values for various forms and conditions of Duranickel.

● **Shear Strength:** Values for the ratio of maximum shearing strength to ultimate tensile strength range from approximately 0.5 to 0.6 and are comparable to those of mild and low-alloy steels.

● **Endurance Limit:** In rotating beam tests of polished specimens at room temperature and 10,000 rpm for 10^8 cycles, Duranickel hot-rolled showed an endurance limit of 51,000 psi.; hot-rolled, age-hardened showed 52,500 psi.; cold-drawn 51,000 psi.; and cold-drawn, age-hardened showed 61,000 psi.

● **Impact Strength:** Charpy impact strength ranges from 240 ft. lb. for hot-rolled Duranickel and 190 ft. lb. for cold-drawn, to 40 ft. lb., for the age-hardened condition.

● **Spring Properties:** Duranickel wire can be cold-drawn and age-hardened subsequently to develop tensile strength of the order of 225,000 psi. The torsional proportional limit of cold-drawn and age-hardened wire is about 40 per cent of the ultimate tensile strength. Duranickel springs are used at temperatures up to 550°F.; the stresses used should be governed by existing service conditions.

● **Working Characteristics:** Duranickel may be hot-worked, forged, and cold-worked. It can be machined most readily in the annealed condition and is commercially machinable in other conditions at hardnesses up to 275 BHN. The use of a cutting lubricant is essential for all machining work because Duranickel, like all high-nickel alloys, is characteristically "sticky" and tends to gall or build up on the tools. Duranickel can be joined by the usual welding, brazing and soft soldering processes common to industry.

● **Variants:** For special uses there are two alloys similar to Duranickel. They are: (1) Duranickel "R" containing a higher percentage of carbon for use where applications require optimum machinability. (2) Permanickel® having the same mechanical properties as Duranickel but different physical constants, particularly better electrical and thermal conductivity and stronger magnetic properties. Permanickel is preferred for service as springs requiring high electrical conductivity; equipment requiring good thermal conductivity and magnetostrictive units where high fatigue strength is required. Special applications include thermostat tension springs, reaction springs, clips, grid wires and side rods in vacuum tubes.

● **Corrosion Resistance:** The corrosion resistance of Duranickel in all its forms is of the same order as that of nickel to a wide variety of media, including mineral and organic acids, alkalies, salts, potable and industrial waters, food products, organic compounds and oxidizing atmospheres at normal and elevated temperatures.

● **Forms Produced:** Duranickel is supplied in most commonly used mill forms—rods, hexagons, squares, rounds, flats, strip, sheet, wire and welding materials.

● **Applications:** Duranickel is used in many applications where corrosion resistance, high hardness, and great strength are required. In the production of plastics, Duranickel is a standard material for dies, injection cylinders and extrusion screws. Duranickel springs, from both wire and strip, give excellent service. Instrument parts include diaphragms, bellows, flapper valve discs, snap switch blades, and grid wires and side rods in vacuum tubes.

Mechanical Property Ranges of Duranickel

Form and Condition	Tensile Strength 1000 psi.	Yield Strength (0.2% offset) 1000 psi.	Elongation in 2 in. per cent	Hardness Rockwell C
Rod and Bar				
Hot-finished	90-130	35-90	55-30	75B-22
Hot-finished, age-hardened	160-200	115-150	30-15	32-42
Cold-drawn, as-drawn	110-150	60-130	35-15	90B-32
Cold-drawn, age-hardened	170-210	125-175	25-15	32-42
Strip				
½ hard	130-155		15-3	25-34
½ hard, age-hardened	170-210		20-7	33-42
Spring	155-190		10-2	30-40
Spring, age-hardened	180-230		15-5	36-46
Wire				
Spring	160-200		5-2	
Spring, age-hardened	200-240		10-5	

FURTHER DATA AVAILABLE

A 22-page reference manual, *Engineering Properties of Duranickel*, Technical Bulletin T-32, contains all essential engineering information. It is available, free, for your files. For help on specific metal problems, write directly to Inco's Technical Service, outlining your problems.

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Dirt and water will not ruin your lubricating oil if you use a De Laval centrifuge to purify the oil. For the De Laval machine will remove both the ***solid*** and the ***liquid*** impurities that so easily contaminate lubricating oil.

Centrifugal force, applied most effectively in the De Laval bowl, throws dirt out of the oil and stores it out of harm's way until cleaning time. The dirt that has been removed cannot re-mix with the oil and contaminate it all over again, nor can dirt store up within the purification area to lessen the ***effective*** centrifugal force. As far as water is concerned, once it is centrifuged out, it is gone — discharged to waste.

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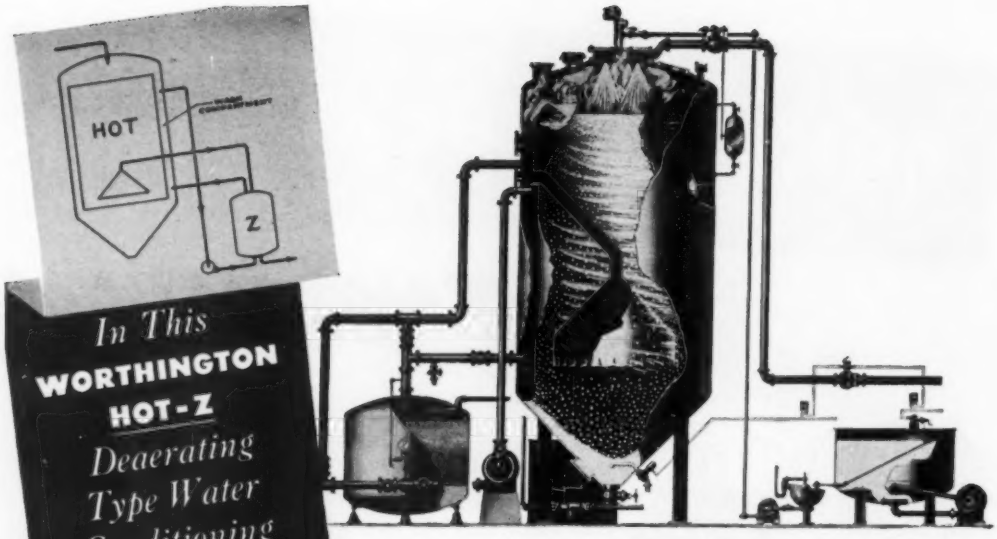

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Built-In Annular Wash Water Compartment Supplies and Reclaims Backwash Water *Independent of the Softening Process*

No other Hot Zeolite System offers you so many advantages as this Worthington Hot-Z System. A quick review of the vital facts will show you why.

As you probably know, Hot Zeolite beds require periodic expansion to minimize packing and friction loss, and to insure efficient contact of each Zeolite particle with its share of dissolved impurities. This need for bed expansion occurs not only during the regeneration routine, but also several times during the period between regeneration routines. That's why it is important for you to use clean, softened water, preferably at normal operating temperature, for the reverse flow or "backwash" operation.

Worthington does it!

The Worthington Standard Hot-Z System with its backwash feature provides a built-in annular wash water compartment that supplies and reclaims backwash water . . independent of the system's softening process. In this compartment, backwash water is cleaned and maintained at normal operating temperature.

This backwash feature pays off particularly in systems employing filters because it *makes filter beds last as long as eight years.*

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Worthington Hot Process Systems come equipped with modern, direct contact vent condensers. This means, no more of the scaling trouble that made the old-fashioned shell and tube types such a nuisance.

In addition, Worthington Hot-Z Systems operate on low-priced lime and salt. That's why the average installation saves enough in chemical costs to pay for itself in 3 years.

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It will pay you to investigate the Worthington Hot-Z System thoroughly. Tell us your conditions of service and get our recommendation in terms of dollars and benefits. You'll find in our Hot-Z System, as in so much other equipment, *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Water Treating Section, Dunellen, N. J.*

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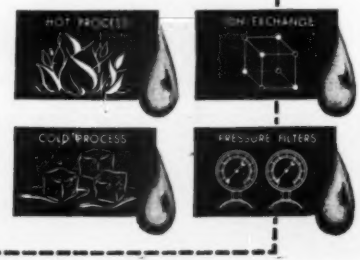
WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems



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Uskorona combines maximum resistance to OZONE and MOISTURE with high tensile strength, elongation and dielectric resistance. Fuses quickly without heat or pressure and makes PERFECT SPLICES.
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USKORONA has been adopted by many leading power companies for underground connections. Ideal for insulating, joining and splicing almost all terminals, circuits, transformer leads and secondary network systems. For full information write address below.

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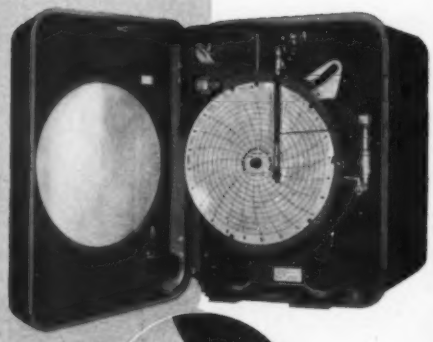

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The only equipment needed for checking a Hagan Ring Balance Meter is the set of calibrated check weights supplied with the meter.

Simply equalize the lead lines, check for zero, place check weights on the ring assembly and read the pen or pointer position.

Each weight is stamped with the equivalent in inches of water differential, and a simple calculation quickly establishes the relation between differential pressure and meter reading.

You can make this test under full static pressure, without high pressure manometers or other cumbersome testing equipment.

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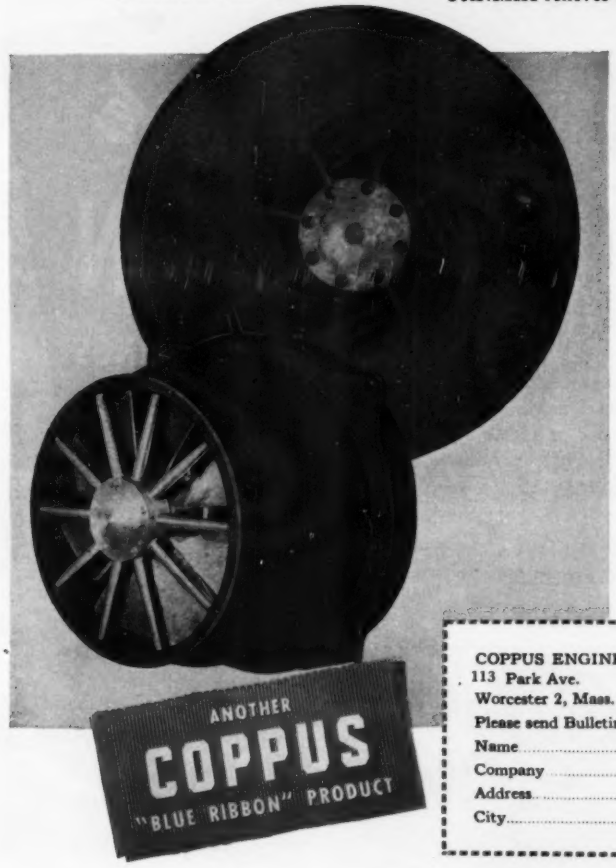

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In all types of Coppus-Dennis **FANMIX** Burners — straight gas or combination gas-oil — we utilize the energy of the fuel under pressure to drive the burner fan and deliver air in the proper proportion to the fuel flow. This exclusive "pinwheel action" *mechanically* mixes fuel and air in exactly the right proportions for truly radiant, non-luminous heat.

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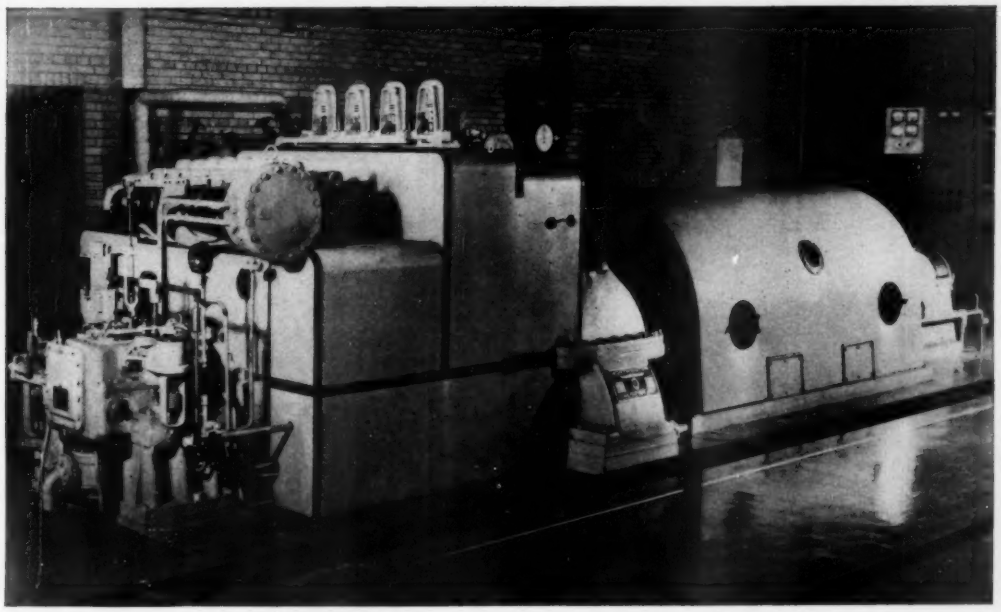

Story of an Economy Drive

How the Worthington Steam Turbine Pays Dividends for the City of Litchfield

What happened at Litchfield, Minnesota, is a clue to a most economical power plant operation.

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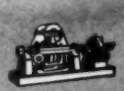
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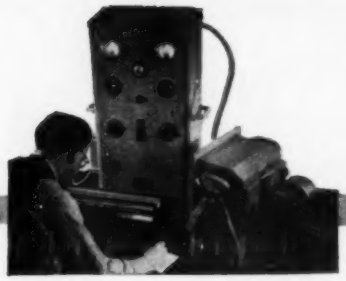

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

INSTRUMENTS AND CONTROLS

101 Electro-Chemical Measurement — Technical Bulletin B61-3 is a 24-pp illustrated text on fundamentals of industrial electro-chemical measurements and automatic control. In it the measurement of pH, redox and conductivity in industrial control systems is comprehensively covered and basic principles of electro-chemical measurements as well as final control elements for automatic control systems are included. Industrial Div., Minneapolis-Honeywell Regulator Co.

102 Speed Recorders, How to Use Them — Catalog N-27 is a 20-pp recent revision of company's manual and ordering book on speed recorders and tachometers. Discusses and compares principles of operation of company's Micromax and Speedomax instruments, pointing out special advantages. Photos show wide range of application for these recorders. A new line of tachometers is also presented. Leeds & Northrup Co.

103 Research into Measurement — Sixteen-pp Bulletin GED-1408 describes work of company's measurements laboratory, showing pictorially how research is conducted into new methods, new materials and devices, and to evaluate manufacturing processes and maintain accuracy of standards. Also covers mechanical and electrical services and test facilities available. Meter and Instrument Divs., General Electric Co.

104 Flame Failure Safeguard — Bulletin CP511, 8 pp, describes a flame scanning tube designed to "see" all types of flames and give instant positive response to flame failure. The tube is a photoconductive cell highly responsive to infra-red, and is designed for continuous use [illegible] temperatures and unusual conditions of humidity and vibration. Its use with company's combustion control systems is discussed; specifications, dimensions given. Combustion Control Corp.

105 Smoke Alarm — This single-sheet bulletin describes and illustrates a visual and audible smoke alarm which makes a continuous record of the density of smoke present in the breeching for any period of time. Tells how alarm operates, lists equipment used, gives dimensions. General Power Plant Corp.

106 Electric Potentiometers — Catalog 15-15, 28 pp, covers company's Electronik electric control potentiometers for both contact and proportional control applications. Fully illustrated, explains controlling principle and advantages of the instruments. Provides engineering and construction data, describes types of control, includes a partial list of available ranges and presents accessories. Industrial Div., Minneapolis-Honeywell Regulator Co.

107 Tachometer Data — Technical Data Sheet 42P describes a tachometer for wide speed ranges. Discusses its features, tells its applications, gives suggestions for installation, use and servicing, also ordering information. Metron Instrument Co.

108 Strip Chart Recorder — Two-pp Bulletin MPC-1, on company's new Multi-point Capscribe, explains how as many as six permanent records of industrial processes may be obtained on one strip chart. The mechanism of the deflection type measuring circuit, and the simple chart printing mechanism used are described. Specifications included. Wheelco Instruments Co.

109 Pump Controls — Bulletin 1210, 4 pp, describes pressure operated pump controls for elevated tank systems using two or more pumps, showing how company's system offers simplified liquid level control, reduced pump operation, other benefits. Fully illustrated, describes features, pump ejection, protection afforded and possible modifications. Sequence of operation detailed. Automatic Control Co.

110 The Story of Instrumentation — This small, 12-pp booklet tells, in brief, non-technical story of instrumentation in every-day life. Covers company's products in more than a dozen fields. Weston Electrical Instrument Corp.

111 Sight Feed Bubbler — This 2-pp illustrated bulletin gives construction details, dimensions and specifications on a sight feed bubbler for gas and air lines to indicate small rates of flow. Includes similar data on a sediment trap for collecting dirt and moisture. King Engineering Corp.

PIPING, VALVES AND ACCESSORIES

112 Valves for Viscous Liquids — Illustrated Bulletin W-425-B4, 4 pp, presents manufacturer's Rolin valves for use with viscous liquids and liquids with solids. Explains counterrotated flow, reduced turbulence, reduced wear, other advantages. Describes and pictures pump applications. Worthington Pump & Machinery Corp.

113 High Pressure Gate Valve — Described in 4-pp Form DE-272 is a forged steel gate valve designed for long service and low cost maintenance. Cutaway and line drawing shows construction features. Working pressures, sizes and prices listed, also available materials. E-P & C Valve Div., American Chain & Cable Co., Inc.

114 Pre-Fabricated Piping — Bulletin WPI, 8 pp, discusses advances in the field of high and low pressure piping subfield of high and low pressure piping sub-

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assemblies. Describes and pictures pipe bends, coils, headers, manifolds, Vanstone work, process piping, and welded assemblies. Also described are facilities for fabricating jobs from carbon steel, carbon moly, all alloys and stainless steel piping. Western Piping Supply Div., The Lummus Co.

115 Safety Head Catalog — Section 10, Part 1 of Catalog 54 offers 52 pp of informative reading on safety heads. Written in non-technical language and fully illustrated with cutaways and installation photos, it contains charts and tables covering almost any phase of safety head information desirable. Tells where safety heads can be used and how to use them. Gives advantages of manufacturer's line in protecting pressure equipment. Tells how to choose safety head assemblies and rupture discs. Includes tips for lowering temperature at point of safety head location. Black, Sivalls & Bryson, Inc.

116 Pipe Tool Operating Guide — Form O.G. is a concise 4-pg folder prepared to help users get best possible results from portable pipe and bolt machines and hand pipe tools. Illustrated with simple drawings, tells quickly how to locate and correct pipe machine and hand pipe tools troubles; covers 31 operations. Main sections are on threading, cutting, reaming, driving geared tools, oil pump, and electrical data, and care of dies. Beaver Pipe Tools, Inc.

ENGINES, TURBINES AND ACCESSORIES

117 Diesel Engines — Four-cycle, direct injection, totally enclosed diesels for industrial and municipal plants are the subject of Bulletin S-650-B824. Photos show component parts, large sectional drawings illustrate design features. Full specifications presented, operation explained. Economy, simplicity and other features described. Bulletin is ring-punched for filing in binder. Worthington Pump & Machinery Corp.

118 Vertical Drive Steam Turbine — The turbine described in Booklet VT351, 4 pp, comes in three general sizes for industrial applications to 600 hp with thrust loads to 9000 lb and steam conditions up to 900 psig and 900 F. Construction features and application of this type of turbine to boiler feed pumps, refineries, geared circulating pumps are discussed briefly. Whiton Machine Co.

119 Fifty Years of Turbines — This attractive 40-pp anniversary booklet covers turbine history as experienced by a large manufacturer of this equipment since 1901. It's filled with photos of early and recent models and also covers development of pumps, blowers and compressors, and speed reducers. DeLaval Steam Turbine Co.

120 Oil Reclaimer — An oil reclaimer for diesel or gas engines that's continuous, automatic and electrically operated is described in Bulletin R-238, 4 pp. Reclaiming process is explained and illustrated by full-color drawing. Also pictured are other reclaimers, purifiers. The Hilliard Corp.

ELECTRICAL, LIGHTING

121 Buyers' Guide on Testing Instruments — Sixteen-pp Bulletin GEA-5499 covering electrical testing instruments introduces the new hook-on power-factor meter for measuring power factor quickly without interrupting service. Other instruments pictured and described as to characteristics and applications include hook-on voltammeter, hook-on wattmeter, recorders, indicators, resistance meter, tachometer. Prices, selection chart included. Meter and Instrument Divs., General Electric Co.

122 Large Induction Motors — Where the large polyphase induction motor fits into the industrial picture is told in 28-pp Booklet B-4720. Presents a quick summary of the two basic kinds of induction motors — squirrel cage motors for constant-speed drive, and wound-rotor motors for adjustable-speed drive. Unit-type stator and all-metal rotor are discussed and bearing accessibility illustrated, as are other construction features. Applications are illustrated for a number of industries. Westinghouse Electric Corp.

123 Instrument Transformer Buyers' Guide — A well-illustrated, 60-pp brochure, GEA-5026, gives buying information on company's instrument transformers. The publication is divided into sections offering technical data on indoor and outdoor potential transformer, current transformer, metering outfits, potential and current portable transformers. Listings of ratio and phase-angle tests, coupled with tables covering mechanical and thermal limits of current transformers are included. Meter and Instrument Divs., General Electric Co.

124 Know Your Calibration Symbols? — Here's a handy 8½ by 5½ in. chart showing the applications, calibration symbols, conductors, polarity, also IRA, military, and company's own color codes of thermocouple and extension wires. Resistance tables for these wires are shown on the reverse side. Thermo Electric Co., Inc.

125 Lighting and Nation's Welfare — This 24-pp report, prepared as a public service, summarizes vital present-day services of illumination in industrial production, public safety, research and education, and in government. It is divided into sections covering office lighting, production lighting, protective lighting, public safety lighting and education in lighting. The National Information Committee on Lighting.

WATER TREATING

126 Got a Water Problem? — Sixteen-pp Bulletin 501 tells how company can help both those plants doing their own testing and treating and those requiring outside laboratory services. Summarizes briefly 10 impurities common in water, damage caused by them and ways to combat them. Describes products and services offered in treatment of boiler water, water lines, cooling water systems, brine systems, also waste water treatment, zeolite softener treatments, consulting services. Brooks Chemicals, Inc.

127 For Efficient Algae Control — Bulletin 52, 4 pg, describes a copper-citrate combination, developed for low cost algae control in cooling systems, municipal reservoirs, pools. Gives typical dosages, includes test data on solubility on varying pH conditions. National Aluminate Corp.

128 Ion Exchange Systems — Here's a folio of catalog sheets on ion exchange systems in capacities from 20 to 1000 gal per hr. Each sheet is illustrated, with photo and working diagram of a particular model, lists its features, specifications, performance characteristics. By referring to "total ionized solids" in raw water column of the performance chart, a power engineer can quickly figure chemical costs of operating

(Continued on page 118)

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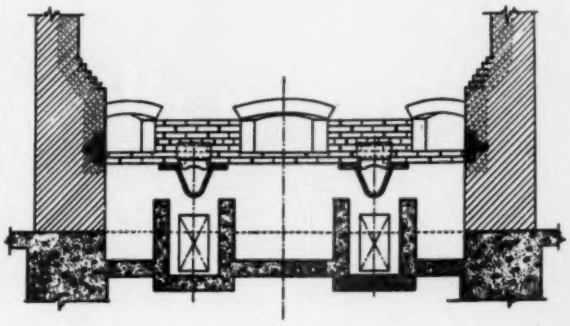
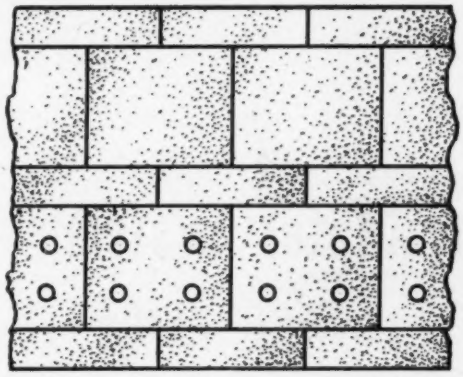
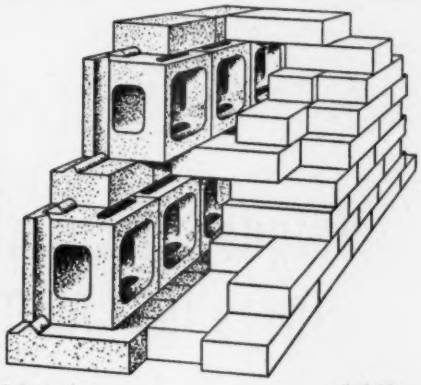


Solid Crystolon Brick Construction



Front View



Crystolon Air Cooled Block Construction

Back View

Because:

NORTON CRYSTOLON* BRICKS OR AIR COOLED BLOCKS at the clinker line, as detailed above, are: (1) so highly refractory that they successfully stand temperatures up to 2900°F; (2) so dense that they effectively resist slag penetration and clinker adhesion; (3) so hard that they are not noticeably affected by abrasion, even that caused by the moving fire bed of stoker-fired furnaces.

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WRITE FOR BULLETIN 862

For all the reasons why Norton Crystolon silicon carbide brick is your best buy for long service and low maintenance cost, consult your nearby Norton representative or write direct for Bulletin 862. Norton Company, 615 New Bond St. Worcester 6, Massachusetts.

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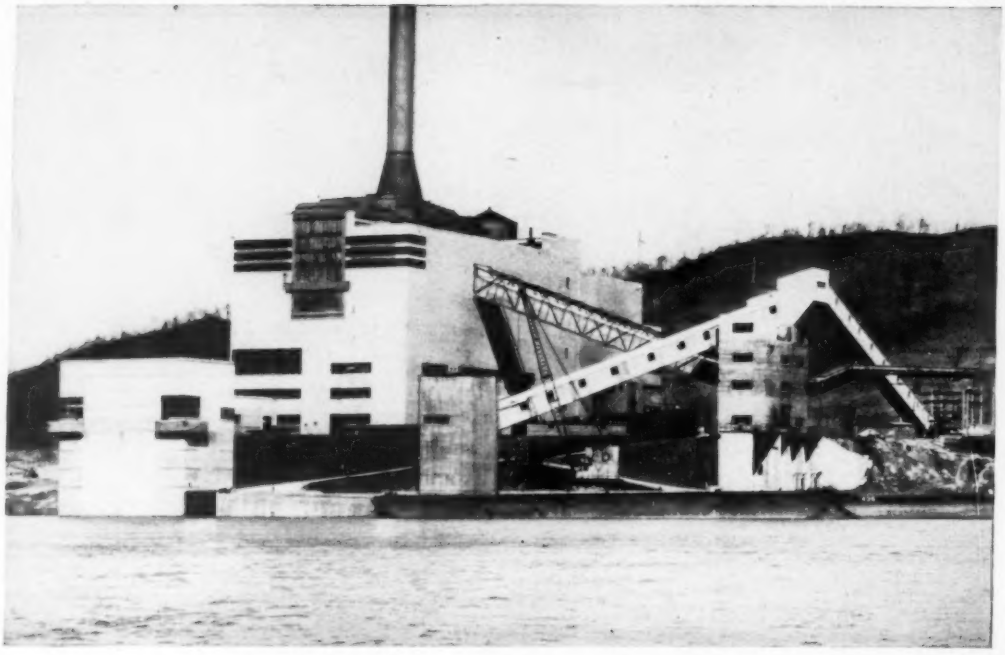

Unique Circulating Water System Installed in This Power Plant

The R. E. Burger steam-electric plant of Ohio Edison Company is located on the Ohio River well above flood stage—which may reach as much as 60 feet above extreme low water. Water is supplied to the condensers by a patented circulating water system pioneered jointly by Worthington and the consulting engineer, Mr. George W. Saathoff.

All major equipment except circulating pumps, which are designed to operate completely submerged if necessary, are located above flood stage.

The new installation of a Worthington 70,000 sq ft two-pass condenser and auxiliaries, serving a 90,000 kw turbine-generator, is the third Worthington unit in this station. Two 46,000 sq ft condensers were previously installed.

For advice on any new installation or information on a wide range of power plant equipment, consult Worthington Pump and Machinery Corporation, Steam Power Division, Harrison, New Jersey.

HOW IT WORKS

Two full-capacity circulating pumps are used in series.* The primary pump, submerged below extreme low water, is a Worthington motor-driven HIFLO. Its high starting head characteristic is able to deliver enough water for starting purposes. A booster pump—a single-suction volute Worthington MIXFLO, mounted directly upon an hydraulic turbine—starts when there is enough water in the control well. The two pumps then operate automatically in series at full capacity.

Advantage is taken of maximum siphon effect from the condenser drop leg which enters the sealing or control well. From this well, all circulating water is passed through the hydraulic turbine. Thus the static head from sealing well to river level is utilized—75-80% being recovered—in reducing the work of the primary pump, with saving in overall pumping power.

The booster pump functions until rising water renders the turbine ineffective. Then the primary HIFLO works alone, producing full capacity under reduced head.

*In the new unit, there are two half-capacity primary pumps, permitting operation of only one in the winter when low water temperatures prevail.

Z.1.1

WORTHINGTON

WORLD'S BROADEST LINE OF STEAM POWER PLANT AUXILIARIES

Feed Water Heaters · Boiler Feed Pumps · Steam Turbines
Steam-Jet Ejectors · Water Treating Equipment · Surface Condensers

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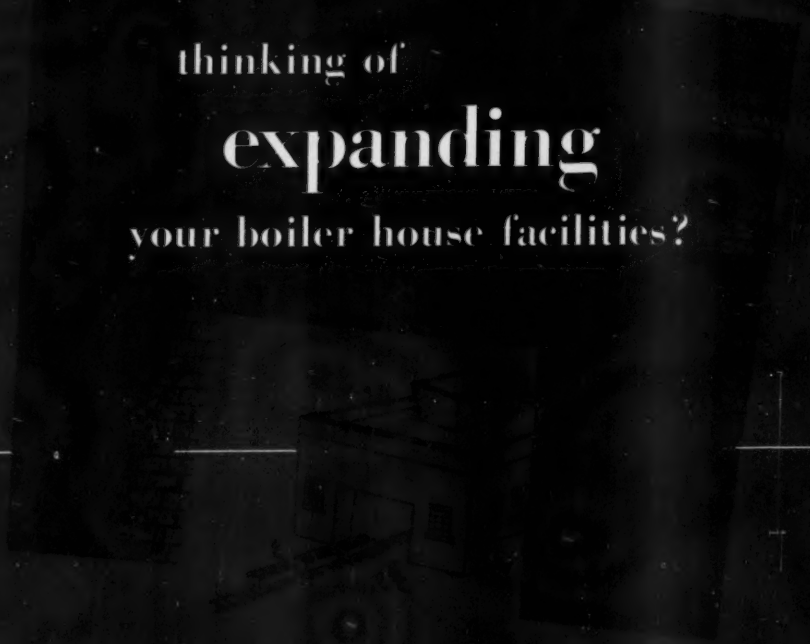
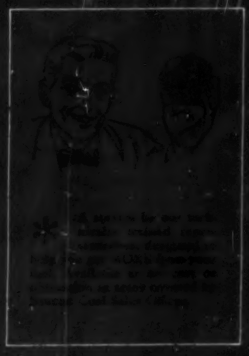
expanding

your boiler house facilities?



Beacon Combustion Service

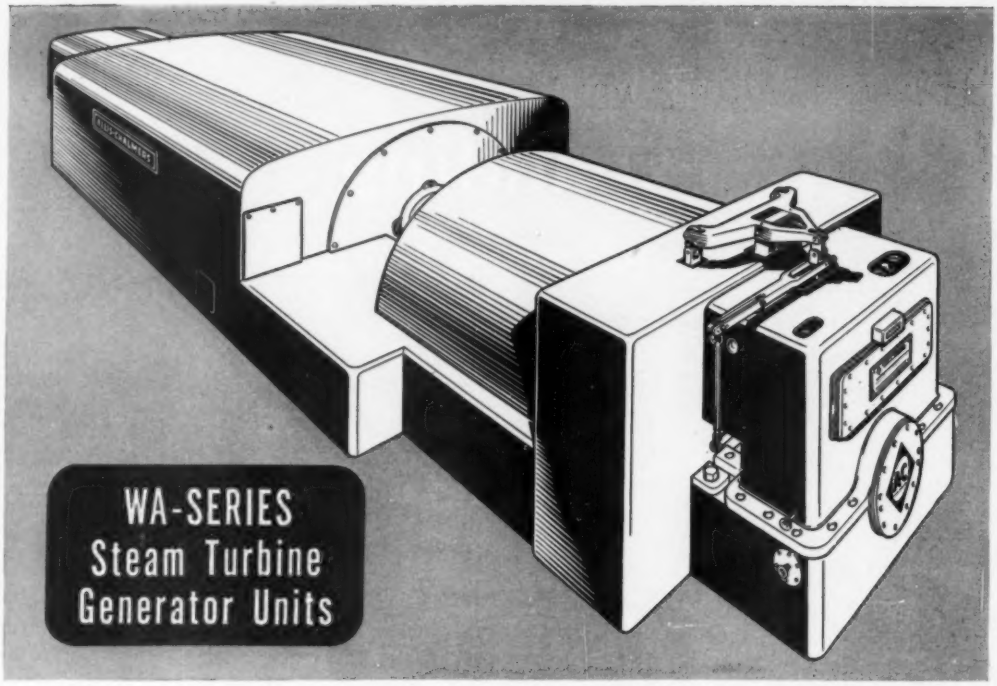


EASTERN GAS AND FUEL ASSOCIATES

EASTERN GAS AND FUEL ASSOCIATES

PITTSBURGH BOSTON CHICAGO CLEVELAND DETROIT NEW YORK
NORFOLK PHILADELPHIA SYRACUSE

For New England: New England Coal & Coke Co., *For Export:* Castner, Curran & Bullitt, Inc.



Make Your Process Steam Serve Double Duty!

WHEN YOU'RE GENERATING process steam, you can save substantially by also generating electric power as a *by-product!*

For if you need a large amount of steam anyway, it costs only slightly more to establish higher pressure steam conditions for operating a turbine-generator unit as an efficient pressure-reducing valve. Process steam leaves the turbine at controlled pressure; power is generated as an economic by-product.

Allis-Chalmers modern WA-Series impulse steam turbine generator units are built especially for the economies inherent in such applications. WA-Series unit designs fit into your plant; tie in thermodynamically, as well as electrically paralleling with other units or systems.

They are being built in NEMA ratings through 7500 kw, for both condensing and non-condensing service, with or without automatic extraction. The WA-Series brings to the industrial and utility power plant the economies of repetitive manufacture as well as the design refinements proved by long steam turbine generator experience.

Purchaser convenience and simplicity are paramount in WA-Series design. Three-bearing construction, above-floor oil piping and bracket-bearing, housing type generator—all make a compact unit with simple foundation requirements.

Get the *full* story on the modern WA-Series! Be sure your next generating unit has *all* the latest features. Call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wis., for Bulletin 03B7664. A-3443

ALLIS-CHALMERS

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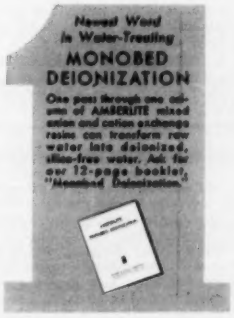
World's Widest Range of Power Plant Equipment

WATER OF MOUNTAIN STREAM QUALITY FOR YOUR BOILERS—AT YOUR DOOR

Melting snow, near the source of a mountain stream, gives unusually pure natural water. Nice if your power plant is nearby. But if it isn't . . .

You can still feed your boiler highest quality water, by treating it with AMBERLITE deionizing resins. For an AMBERLITE Ion Exchange unit can reduce total ionized solids virtually to zero. That means zero silica, zero carbon dioxide, zero hardness—all at low cost. AMBERLITE units are trouble-free, too. And they give you an assured supply of the water you need, despite wide variations in the *quantity* demanded and *quality* of the raw water supply.

Tired of fuel-consuming evaporation or low capacity, unstable exchangers? Then discuss AMBERLITE deionization with your consulting engineer or water-conditioning-equipment manufacturer. He'll be glad to show you how to adapt the various combinations of AMBERLITE resins to your specific water conditions.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One pass through one column of AMBERLITE mixed anion and cation exchange resins can transform raw water into deionized, silica-free water. Ask for our 12-page booklet, "Monobed Deionization."

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NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the non-obligation, postage-paid card pages 37–38.

1—TESTING INSTRUMENT

Is time saver, combining functions of sensitizer and split plug

The Amprobe 10 x Sensitizer, which combines services of company's original sensitizer with the 1x Split Plug, is changed from one to the other by means of a two-position switch. The new instrument is designed for easier and precise readings on small appliances and motors of ¼ hp or less, multiplies the sensitivity of the Amprobe ten times. This accessory adds three low-current ranges to the Model A-6 Amprobe: 0–1 amp, 0–2.5 amp, and 0–5 amp.

A shift of the switch to the 1x Split Plug doesn't increase the sensitivity, but facilitates snap-on current readings of equipment having sealed double-conductor electric cord, company explains. When plugged in between equipment being checked and the outlet, it separates conductors instantly without touching wire. Pyramid Instrument Corp.

2—ANTI-CORROSIVE

For protecting boilers, other metal surfaces, comes in four grades

Corrosanti, a new treatment which reacts upon the metal treated and not on the water surrounding it, is made in grades for four types of corrosive conditions. Grade A is for the protection of boiler metal surfaces and is designed to remove all scale deposits and prevent rust, pitting and corrosion. Company explains that as the old boiler scale is penetrated by the Corrosanti, it enters the pores of the boiler metal and automatically seals them. It is injected through the feed line. Grade A Corrosanti is also said to prevent electrolysis within boiler and to be harmless to valves, pumps, gaskets.

Grade B is for protection of ferrous metals subjected to deteriorating influences of water and water vapor. Acting as a rust inhibitor it penetrates rust formations to cause the rust to flake off. Applied with a short, stiff-haired brush, this preparation is reported to cling to wet, rusted surfaces and to be equally effective when applied under water. It is suggested for water tanks and towers (inside and outside), open air condensers, catwalks, underground piping.

Corrosanti Grade C is for metal surfaces subjected to acid and other corrosive vapors, gases, acid-forming conditions, salt water, and brines. Applied by brush, it is described as particularly adaptable for marine use, and wherever iron is submerged in or carries brine. A fourth grade, Corrosanti Special, is for ferrous structures subjected to temperatures of 900 F, such as smokestacks, boiler fronts, flues and uptakes. All grades of Corrosanti are packaged in 5 gal containers. Research Laboratories of Dr. Schror, Inc.

4—AIR CIRCUIT BREAKER

Features new air-delayed series overcurrent tripping device

Latest of manufacturer's DB line of breakers for application in low voltage industrial and commercial power distribution systems, motor starting duty and similar uses is the Type DB-50 with an interrupting capacity of 50,000 amp. The DB-50 has completely adjustable elements, company points out, and provides long-time delay on overloads and instantaneous tripping of fault currents.

The DB is rated at 600 v a-c, 250 v d-c and has a continuous rating of 100 to 1600 amp. It can be operated manually or by d-c solenoid or a-c Rectox solenoid. All parts are removable as complete units. For use on feeder and back-up breakers, overcurrent trip units including both a long-time delay and short-time delay element can be specified. Westinghouse Electric Corp.

5—VALVE ACTUATORS

For operating gate, plug, diaphragm and butterfly valves

These actuators are basically company's cylinders equipped with brackets, valves, controls and couplings to make them suitable for almost any type of operation required. They can be adapted to any make, size and type of valve, manufacturer says, to work on any fluid medium and with any pressure available. They can be arranged for on-and-off service or for positioning service. Ledeen Mfg. Co.

6—TRIPLEX PUMP

Is 3-in. stroke unit, designed to operate at speeds to 500 rpm

The Direct Flow Pump was so named because it passes liquid in a straight line, directly through the working barrel. Company engineers eliminated two right angle turns in the fluid-end block to effect a reduction of "loss space" in the fluid-end. This is credited with improving volumetric efficiency and saving

materials. The fluid-end is sectionalized in construction so maintenance is simplified, and change in plunger size can be made to meet alterations in pressure or capacity.

Offering higher speeds than company's previous models this unit is built to provide more work from a lighter, more compact pump. Power ranges to 50 hp, pressure to 3800 psi and displacement to 96 gpm (3275 bbl per day) at 790 psi, 500 rpm. The Aldrich Pump Co.

7—LAMP ANNUNCIATORS

Heavy duty type, for all voltages up to 250 v a-c

The Type ANN18 Lamp Annunciator uses lamp units with 2-in. beehive lenses and engraved lamicoid designation strips. The relays are the plug-in type and mounted directly to the rear of the lamp units. Lamp units are also available with flat lenses for indication markings to eliminate designation strips. These flat lenses can be glass with markings on the lens or lamicoid with engraved designations.

Automatic service provides an audible as well as visual signal, and cutting off of the audible signal for one section doesn't prevent receiving of audible signal from other sections that may become abnormal. These annunciators are for use with S6 and T2 type bulbs. They supervise pressure, temperature, vaults, switches. The H. R. Kirkland Co.

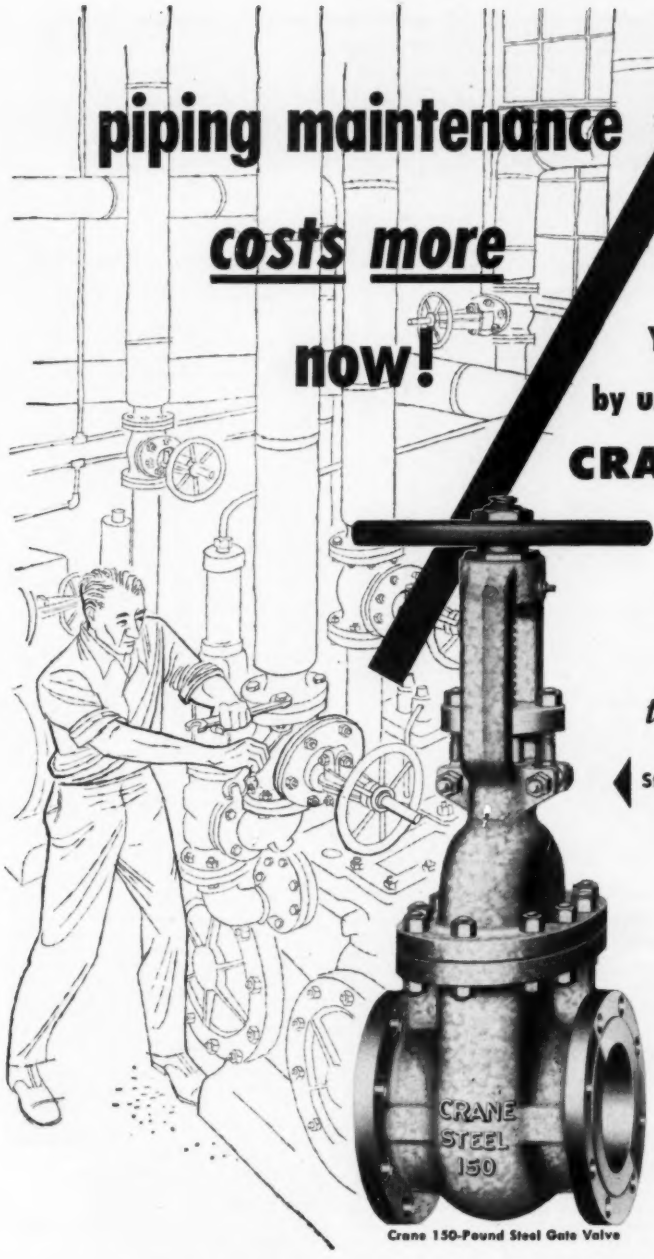
3—STOCKPILING-RECLAMATION UNIT

Of 60,000 lb or 18 cu yd capacity; is self-loading, powered by twin engines

One of the newest developments in coal handling on stockpiles is the Twin-Power Scraper, which is powered by two diesel engines of 175 or 190 hp each and has a top travel speed loaded of 30 mph. Each engine powers a drive axle through a torque converter and hydraulically actuated automatic transmission. One engine is conventionally mounted in the tractor unit and the other is located at the rear of the scraper. The operator can control either engine independently or synchronize them.

Advantages stressed for the Twin-Power Scraper are its ability to self-load loose or compacted coal quickly, to spread it in layers or dump it into hoppers. Operating and maintenance costs are low, according to manufacturer, and its use permits stockpiling as a protection against short supply emergencies. The Euclid Road Machinery Co.

piping maintenance *costs more* now!



Crane 150-Pound Steel Gate Valve

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You can practically forget valve maintenance worries with Crane Cast Steel Wedge Gates. They're unusually rugged . . . amply reinforced at all stress points. Disc is precision-guided to reduce seating surface wear. Straight-through ports give smooth flow, with minimum turbulence and erosion.

Stuffing box depth and design assure tight stem seal . . . long packing life. Valves available in trim materials for steam, water, gas, oil, and oil vapor services.

Ask your Crane Representative about the better quality and greater dependability of Crane valves—your assurance of on-the-job performance that spells lower final cost.

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8—EXCITER DEVELOPMENT

For rotating amplifier-type generator voltage regulator

Latest development announced in connection with company's Regulex is a voltage measuring and control panel with no moving parts or electron tubes. This static regulating equipment is built in standardized panel sections to be mounted in either cubicle or switchgear units. It consists of a compensating unit for reactive current division, stabilizer panel, static voltage measuring circuit, battery excitation switch and resistor, and damping transformer assembly mounted from top to bottom in the cubicle. A knob on the front of the reactive compensating units adjusts the autotransformer, while reactors and other units are mounted on the rear of the panel.

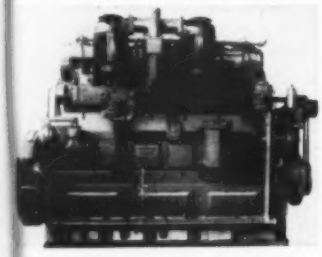
Besides the improved cubicle, the equipment includes a Regulex motor-generator set, manually or motor-operated main exciter field rheostat, voltage adjusting equipment. The Regulex exciter is described as extremely versatile when applied to control of synchronous machines. Standard elements are available not only to control voltage, power factor or current, but also to prevent over- or under-excitation. Allis-Chalmers Mfg. Co.

9—GAS-BURNING DIESEL

Is designed to take advantage of natural gas in oil producing areas

Now in production, the Model LR-600-GAS is expected to be used primarily to provide economical power for oil well drilling rigs, but will have other applications wherever there is an abundance of natural gas, as in pipe line pumping stations and municipal power plants. Its 1100 rpm rating puts it in the medium speed classification.

The LR-600-GAS is a six-cylinder, spark ignition engine with displacement



of 2477 cu in, a bore and stroke of 7¼ by 10 in. and maximum rating of 315 hp. It is equipped with gas carburetor, mixing valve, magneto and special accessories for gas operation. Air starting equipment is standard, and a 32-v electric starting system is optional. Two oil bath cleaners are provided, as well as a mechanical flyball type governor and water-cooled exhaust manifold. Engine weighs 7500 lb, has compression ratio of 6.8 to 1. Cummins Engine Co., Inc.

10—THREE POLE RELAY

Is mercury plunger contact type, employing one coil

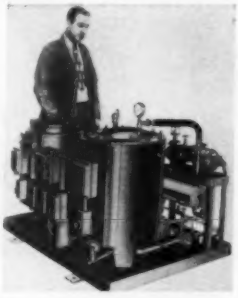
In the new Type Em-7 Relay the tungsten contacts are hermetically sealed in hydrogen-filled glass tubes, and three of company's Type EMT tubes are used in the one coil structure. This construction is designed to provide a reliable and positive simultaneous contacting means for loads up to 35 amp at 115 v a-c, or 25 amp at 220 v a-c per contact.

These relays can be supplied with all three contacts normally open or normally closed, or with any combination of normally open and normally closed contacts. Relay is 4⅛ in. wide, 5⅜ in. tall, 3 in. deep. Ebert Electronics Co.

11—OIL CONDITIONER

Is 35-40 gph unit, specifically for small-batch clarification

This new conditioner is intended for small-batch clarification of used hydraulic, lubricating, run-in and transformer oils. Both insoluble and soluble



impurities are reported to be completely removed by this unit which combines a cartridge filter (for removal of metal, gums, tars, residues, soot, carbon, dirt and sand) and a vaporizer (for extraction of water, fuel dilution, air and gases).

Advantages announced for this smaller unit include simplicity, convenience and economy in purifying turbine, circuit breaker, transformer, vacuum pump, cable, compressor and refrigeration oils. Cartridge filter and vaporizer are mounted on a common base, portable if desired, and are complete with electric and pump connections. Filter and vaporizer may be operated singly or together. Filtration Div., U. S. Hoffman Machinery Corp.

12—SERVICE FITTING

For raceway line, is fastened directly to the floor

The Catalog 761-B is a service fitting for company's raceway line. The body of this fitting is 14-gage steel and is designed to preserve a continuous raceway base. It is so constructed as to eliminate hazards from abuse and water seepage, company states, and is electro-galvanized to make it rust resistant.

The housing is installed over raceway base without cutting the raceway. After installation of housing and "laying-in" of conductors, the capping of the two-piece raceway is snapped into place and the receptacle wired. While fitting is furnished with duplex receptacle, it accommodates standard devices. Because this fitting is fastened to floor it is said to assure a rigid installation, as well as positive grounding. National Electric Products Corp.

13—DELAYED ACTION RELAY

For use with diaphragm control valves required to operate in series

The Climax Type 227 Relay has body and diaphragm casing of cast bronze with stainless steel inner valve assembly and oil resistant neoprene diaphragms. It incorporates a spring of sufficient power to delay opening of the output port until a certain fixed loading pressure has been reached. This fixed spring loading is permanently absorbed, company explains, and only loading pressures above the pressure absorbed by this spring will affect the relayed ratios.

By the use of one or more of these relays with company's Climax Type 217, regular standard (3 to 15 lb) range control valves can be fully travelled with primary control pressure changes as low as 2 or 3 lb, company adds. Black, Sivalls & Bryson, Inc.

14—HIGH SPEED CHAIN DRIVE

Is developed to offer ruggedness of gear drive, smoothness of belt

The new Hy-Vo (high velocity) Chain Drive makes possible single drive units capable of transmitting up to 5000 hp at linear speed to 6500 fpm, or rotative speeds to 3600 rpm, according to company engineers. They point out that this drive permits the use of smaller, less expensive power plants, an increase in speed with narrower widths, and the elimination of many accessories. The Hy-Vo is claimed to increase efficiency and reduce costs wherever single motors or engines are used in sizes of 100 hp and up.

Its improved performance is credited to a new chain-and-sprocket engagement principle intended to eliminate "chordal" or polygon action, a form of vibration which shortens chain life. Hy-Vo sprockets have curved involute teeth, and the chain incorporates a compensating rocking joint. During articulation the joint shifts the pitch line automatically, engaging the sprocket teeth so the chain follows a path tangent to the sprocket pitch line to effect smooth, almost vibrationless action. "Stretch" is said to be reduced to the point where take-up is almost unnecessary.

Company engineers emphasize that the Hy-Vo supplements, rather than replaces, roller or silent chain drives. It is intended for high speed applications and to replace unwieldy belt drives. Morse Chain Co.

15—PIPE CONDUIT

For one-pipe underground installations, or with several small pipes

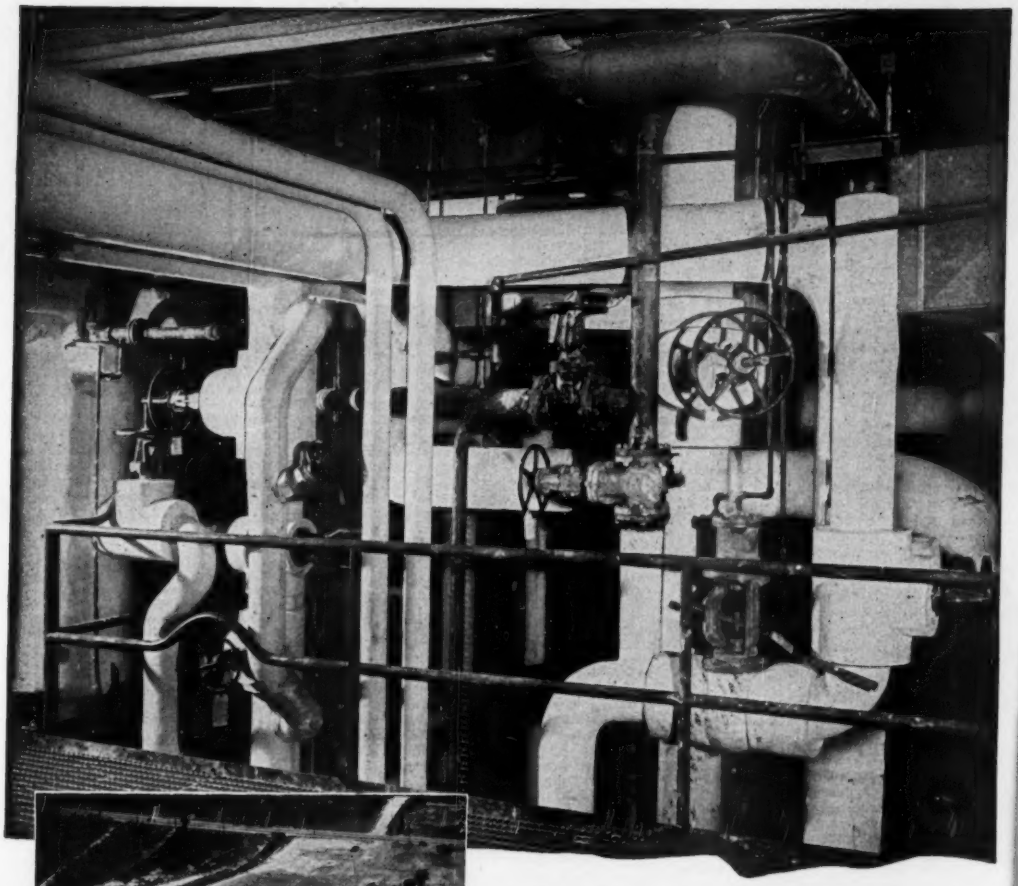
The U-Tile Type Conduits are shipped to the job as "flattened cylinders," scored longitudinally on both of the flattened sides. Tapping over each scoring with a hammer splits the cylinders into two "U" tiles. A circumferential scoring at one end of each tile when chipped off provides a rough-edged bevel which permits the jointing mortar to key and bond into the channels formed within the tile sections. This is designed to make possible strong, tight, flush joints which can be sealed with asphalt waterproofing mastic. H. W. Porter & Co., Inc.—Reid Hayden, Inc.

16—MAGNETIC RELAYS

Are a-c voltage sensitive power type, for control applications

The new Bulletin 401 Relays are intended for use in a-c circuits where a close voltage differential between relay pick-up and drop-out is needed. A typical application is protecting a-c motors up to 2 hp against damage by low line voltages. Other uses include power and lighting bus transfer and, in some cases, over-voltage protection.

Standard units consist of an insulating base on which are mounted company's



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power type Bulletin 103 or 130 a-c magnetic relay, with single-pole contacts and a small saturable reactor. Relay coil and reactor are connected in series.

Because the reactor imparts nonlinear characteristics to the relay circuit, slight voltage changes across the series combination result in wide current variations required for close differential operation. These relays are said to be chatter-free and capable of switching relatively large amounts of power. Ward Leonard Electric Co.

17—100-V D-C CAPACITORS

Offer double the capacitance designed into same capacitor space

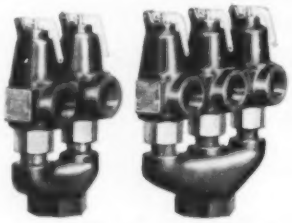
According to manufacturer, these new capacitors meet all requirements of "F" characteristics of JAN-C-25 for 100-v d-c units. For applications where an expected life of 1000 hr is satisfactory the rating can be increased to 150 v and temperatures to 40 C. Test results are reported to show negligible change in capacitance from −40 C to 105 C and the units to give full life expectancy at temperatures to −55 C.

These new thin-paper thinfoil capacitors are described as comparable in all ways to company's previously offered paper dielectric units, and they are smaller and lighter in weight. They won't introduce noise into the system, company says and will pass signal voltages approaching zero. While primarily intended for d-c application with ripple voltages in accordance with JAN-C-25, they will withstand occasional heavy discharges and can also be used in low-voltage a-c circuits under some conditions. Transformer and Allied Products Divs., General Electric Co.

18—RELIEF VALVES

Multiple assembly type, for large hot water heating boilers

Assemblies of two and three of company's Series 33 Safety Relief Valves have been developed for safeguarding larger hot water heating boilers from excessive pressure. These are introduced to meet ASME code recommendations for equipping hot water heating boilers with relief valves having rated discharge capacity equal to gross Btu output of boiler. The assemblies provide a discharge capacity equal to the total capacities of the two or three valves. Thus, No. 233, a two-valve assembly has a total discharge capacity of 496,700 Btu



per hr, ASME rating, and the three-valve No. 333, a capacity of 769,400 Btu per hr.

According to manufacturer, the use of two or three smaller valves with small size orifices circumvents excessive discharge. When boiler pressure reaches 30 psi only one valve opens — enough to take care of normal thermal expansion. But if a "runaway" firing condition causes steaming and excess pressure, the two or three valves open in progressive succession to provide full rate discharge capacity of the assembly. McDonnell & Miller, Inc.

19—SIGNAL TRANSMITTER

Is pneumatically operated flow differential measuring instrument

This high pressure unit transmits proportional signals to remote recording or indicating instruments or to automatic control units. It is used for measuring flow differentials of liquids, gases or vapors, or for measuring static pressure or liquid level. Interchangeable measuring elements cover a continuous range of pressure differential from 5.5 in. water column to 100 psi, at static pressure to 1500 psig.

The transmitter is essentially an input differential pressure measuring unit, force balanced by an output system. The balancing force originates in a modulated loading air pressure resulting from the action on an escapement type pilot valve following any unbalance of linkage forces. Inertia of force balance system is negligible, company points out, and accuracy is within 1 per cent of full-scale reading. Typical applications include steam output of boiler, superheater or evaporator, feedwater flow to boiler, liquid fuel flow to burners. Hagan Corp.

20—PAINT SPRAY EQUIPMENT

Includes new gun using superheated steam

Steam spraying — a comparatively new process in which dry, super-heated steam as an atomizing medium serves to heat the finishing medium — makes it possible to use materials of higher viscosity, allowing the application of heavier coats without sagging or running.

Equipment required may be installed at moderate cost, says manufacturer, and if plant steam isn't available this may be furnished by a small generator. The S-100 Steam Spray Gun is designed to dissipate the heat caused by the steam in the gun and let the operator use it continuously and comfortably with bare hands. Hose supports for steam and materials reduce downward torque on spray head, to make it more easily balanced. Other features include built-in finger guard, adjustable fluid needle and spray head with one-piece steam cap and nozzle.

It is pointed out that steam spraying affords worthwhile savings in finishing material, permits greater material thickness per coat and requires fewer cleanings of spray both because of reduced overspray. Kellogg Div., American Brake Shoe Co.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

VALVES, TRAPS, PIPING

201 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blower, water column blow-down, and other types of pipe line. Includes dimensions, weights; prices. Everlasting Valve Co.

202 Unions and Fittings — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. E. M. Dart Mfg. Co.

203 Blow-Off Valves — Illustrated Bulletin B-433, 24 pp, describes blow-off valves for high-pressure boilers, and covers seatless, hard-seat and unit-tandem types, for working steam pressures from 400 to 2500 lb. Construction details and operating principles are illustrated. Dimensions and specifications included. Yarnall-Waring Co.

204 Popular Steel Valves — Condensed Catalog 104, 28 pp, describes and illustrates most widely used of company's cast and forged steel valves and the data presented for these valves is complete. Those listed are chiefly in the basic steam pressure classes — 150 to 2500 lb — and include globe and angle, gage, instrument, hydraulic and relief types, also strainers, and check, gate, non-return and blow-off valves. Explains design features, gives construction details, dimensions, ratings. Edward Valves, Inc.

205 Valves, Fittings and Flanges — Catalog F-9 is a 400-pp, permanently bound reference book on drop forged steel valves, fittings and flanges for practically all piping needs at high and low pressures and temperatures. Provides not only ordering information on company's complete line, but also much helpful engineering and application data, and includes a section on products for refrigeration service. Fully illustrated, well-indexed. Available to qualified power engineers, please give your title. Henry Vogt Machine Co.

206 Piping Pointers — This is a new 36-pp edition of company's highly popular piping manual covering fundamentals of sound piping practices. Discusses various types of valve designs and how each should be used. Pictures and names more than 80 fittings and contains many illustrated how-to-do-it features. Included with manual is an 8-pp valve selection guide. (Company also offers showings of a 30-min 16 mm training film for use with manual. Information about film is available to power engineers who request it.) Crane Co.

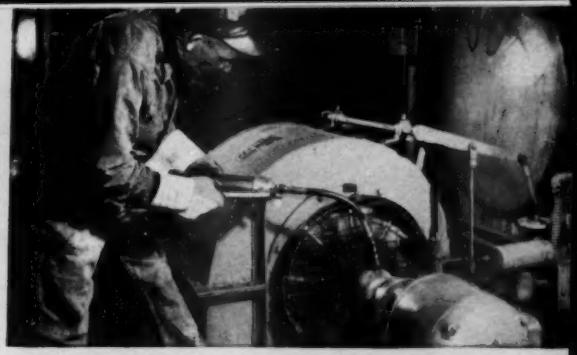
207 Valve Specialties — Included in 90-pp Catalog A-50 is complete ordering and engineering information on automatic pressure flow and liquid level controls for steam, air, gas, water, oil, other fluids. Sections are devoted to pressure regulators, altitude valve, pump governors and strainers; lever, float and motor operated valves, pilot valves; back pressure, relief and non-return valves, steam trap and air vent; liquid level controllers; solenoid valves. Includes capacity charts. Davis Regulator Co.

208 Pressure Reducing Valves — Selection and engineering data on pressure reducing valves, including those for remote control of reduced steam or water pressures, are presented in 12-pp Bulletin 477-A. Northern Equipment Co.

209 Steam Traps and Temperature Controls — Here is a comprehensive catalog comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap selection chart. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Sarco Co., Inc.

210 Steam, Air, Gasoline Traps — This 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 225 lb; expansion steam traps for pressures to 250 lb; weight-operated

TO GENERATE STEAM for manufacturing, Triangle Conduit and Cable uses three 350 hp boilers. Each unit generates 22,500 pounds per hour, 24 hours a day, 5 days a week. *Sun Sohus Oil* lubricates the spreader stoker oil bath, *Sun 844 Grease* the pulley drive, stoker motor and pillow block.



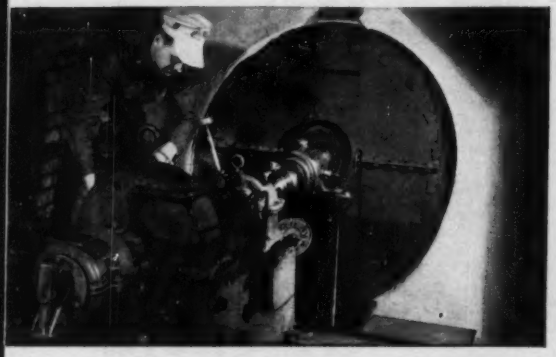
TO CONTROL THE AMOUNT OF AIR entering the fire box, three forced draft fans are kept in constant operation. The motor and fan bearings and the speed reducer motor are lubricated with *Sun 844 Grease*, while the gears and reducers are protected by a *Sun* gear oil.

MODERN POWERHOUSE ENTIRELY SUN-LUBRICATED

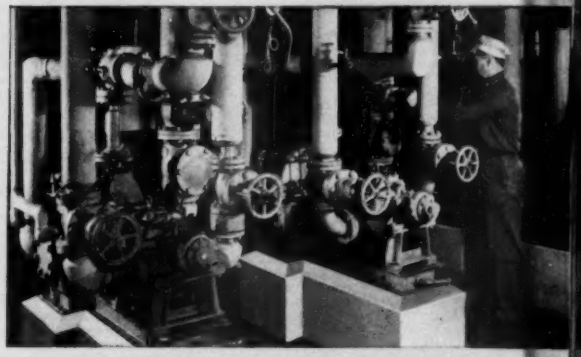
Triangle Conduit and Cable produces flexible and rigid electrical conduit and cable. Its modern powerhouse generates steam for galvanizing pipe and for heating the factory, the pickling vats and the enamel paint vats prior to dipping the pipes. From the very beginning of operations more than two years ago, Sun oils and greases have been used exclusively in all the equipment, and there hasn't been a single failure because of faulty lubrication.

This modern powerhouse is wholly lubricated by Sun "Job Proved" products and the factory partly so. In both, Sun's engineering know-how has effected purchasing and inventory economies through multiple use of a minimum number of oils and greases.

For technical assistance or a copy of the manual "Lubrication of Industrial Machinery," write on your business letterhead to Department PN-7.



TO HELP GET PROPER COMBUSTION in the boilers, three exhaust fans are used. The turbine which drives them turns up 3,600 rpm. The engineer says the lubricant, *Sunvis 951*, looks like new when it is changed to get rid of condensate.



TO FEED WATER TO THE BOILERS, two 3,500 rpm turbine-driven pumps are employed. A motor-driven pump is used in starting up when there is no steam pressure. *Sunvis 951* lubricates the turbines, *Sun 844 Grease* the pump fittings.

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traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lb, and also steam, air and gas separators. Includes capacity tables. W. H. Nicholson & Co.

211 Handbook on Fittings and Flanges — Catalog wf-1950, 88 pp, is packed with working information on seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings in other metals. Grinnell Co., Inc.

212 How to Choose and Use Air Traps — Bulletin 202, 4 pp, describes a line line of air traps, covering their selection and installation for automatic drainage of moisture from compressed air intercoolers, aftercoolers, receivers, separators, drip points. Prices included. Armstrong Machine Works.

213 Safety Valve Engineering Data — How company's safety valve works and its important operating advantages are explained in Bulletin 707, 4 pp. Includes dimensions on flanged and welded inlet valve types, tables on superheat correction factor, capacities. Manning, Maxwell & Moore, Inc.

214 Flanges for Severe Service — This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Goodall Rubber Co.

215 To Get at those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels and makes them readily accessible. Babbitt Steam Specialty Co.

216 Strainers and Separators — Bulletin R-46-50A is a 16-pp catalog on T-type strainers, suction strainers, multiflow and receiver separators. Contains dimensions, weights, prices. Shows how several types have been redesigned for increased efficiency. Dimensions, service pressure ratings. American District Steam Co.

ELECTRICAL

217 The Why of Dry Type Transformers — Booklet B-4428, 24 pp, discusses reasons why dry-type transformers are safer and less expensive to install and maintain in industrial plants and utilities. Types of air-cooled transformers for every use are illustrated from small ones for operation of intercommunication systems to power centers as large as 10,000 kva. Also describes sealed, submersible, dry-type transformers. Westinghouse Electric Corp.

218 Power Factor Correction — Examples showing basic considerations in the improvement of system power factor are contained in Bulletin O5B7465, 4 pp. Points out economical and operational advantages of improving plant power factor and advisability of keeping the load power factor up to 0.8 lagging or higher; tells how the effects of low power factor can be corrected. Allis-Chalmers Mfg. Co.

219 Synchronous Motors — High speed synchronous motors are described in 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features. Elliott Co.

220 Care of A-C Rotating Equipment — To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin O5R7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and such subjects as drying moist insulation, measuring insulation resistance. Allis-Chalmers Mfg. Co.

221 Buyers' Manual on Motors and Control — Fifty-pp Catalog GEC-1009 presents buying information on a carefully selected group of motors, motor starters, control accessories and electronic control. Ratings listed are those most frequently required. Excellent data on proper selection is provided as well as dimensions, ratings, prices. Illustrated. General Electric Co.

PUMPS AND COMPRESSORS

222 Compressor Selection Chart — Here's a chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor, giving quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Worthington Pump and Machinery Corp.

223 Boiler Feed Pumps — Bulletin 109, 16 pp, illustrated in color, describes detail centrifugal pumps for boiler feed service. Explains and pictures construction and major parts, explaining in detail the floating seal incorporated. Capacity data is provided, vapor pressure tables. Pacific Pumps, Inc.

224 Pulsation-Free Compressor Piping — Illustrated Bulletin PDS-8501, 4 pp, describes company's pulsation dampening piping system. Tells how this piping compares in first cost to other piping, but affords higher operating efficiency, other advantages. Explains pulsation phenomena in gas compression systems and how dampening principle is applied. The Fluor Corp., Ltd.

225 Data on Pumps — All Types — Bulletins are available on centrifugal, reciprocating, screw and rotary pumps covering a wide range of capacities and services. Includes information on single and multistage, close coupled, single and duplex piston, and special pumps for handling erosive and corrosive liquids, also high viscosity liquids, both lubricating, non-lubricating. Warren Steam Pump Co., Inc.

BOILERS AND AUXILIARIES

226 Re-Circulation Steam Generator — Here's a 6-pp folder introducing a controlled re-circulation steam generator, describing its development and recommended uses, such as applications where steam is required in remote locations, where demands are intermittent or load fluctuating. Illustrated, text explains operation, features. Combustion Engineering-Superheater, Inc.

227 Packaged Generators — Bulletin SB-38 introduces company's new Keystone model. Photos and sketches show complete unit, pressure element and details of its compact design. Gives advantages of two-drum water boiler, three-pass gas travel, automatic gas or oil burner. Dimensions, capacities. Erie City Iron Works.

228 Shop-Assembled Boiler — Eight-pp Bulletin G-72 introduces company's new integral furnace boiler. Describes and illustrates its economy, ease of installation and connection, flexibility, minimum space requirements, efficient combustion, fast steaming. The Babcock and Wilcox Co.

229 Dowtherm Vaporizer — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer, tells how this unit is designed to evaporate Dowtherm so as to provide dependable operation at maximum temperatures. The Wickes Boiler Co.

230 Tube Expanders — Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators, other equipment. Thomas C. Wilson, Inc.

231 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors, hose. Roto Div., Elliott Co.

232 Streamlined Baffle Walls — Bulletin BW-44, 20 pp, describes company's baffle walls, showing their application to modern boilers and for modernizing existing units. Fully illustrated with photos and drawings covering installations, remodeling designs. The Engineer Co.

233 Air Preheaters — Illustrated Bulletin A-11610, 8 pp, defines air preheat and explains its benefits in terms of increased efficiency and capacity and flame stability. Provides general description of company's preheater, discusses its application to boiler plants. The Air Preheater Corp.

234 Soot Blower Head — Illustrated Bulletin 485, 4 pp, describes a new rotary soot blower head for improved boiler cleaning. Explains how blower head is designed to give maximum blowing pressure through the full blowing arc, is rugged, easily serviced, economical. Vulcan Soot Blower Div., Continental Foundry & Machine Co.

INSTRUMENTS AND CONTROLS

235 For Centralized Control — Bulletin 109, 4 pp, presents the new, compact Mini-Line equipment suited to control board arrangement which concentrates vital operating information and controls for one or more boilers, turbines or process units before a single operator. Describes and illustrates vertical-scale indicator units, selector valve, remote manual relay. Bailey Meter Co.

236 Remote Reading Flow Meters — Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described. Republic Flow Meters Co.

237 Flow Meters — Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1¼ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, bulletin discusses meter's advantages. Builders-Providence, Inc.

238 Putting the Ratio Totalizer to Work — Twelve suggested applications of company's ratio totalizer in automatic control circuits are described and illustrated by diagram in 8-pp Bulletin 5450. This new device is a pneumatically operated control mechanism for combining input control pressures and spring forces to produce a single output control pressure. Hagan Corp.

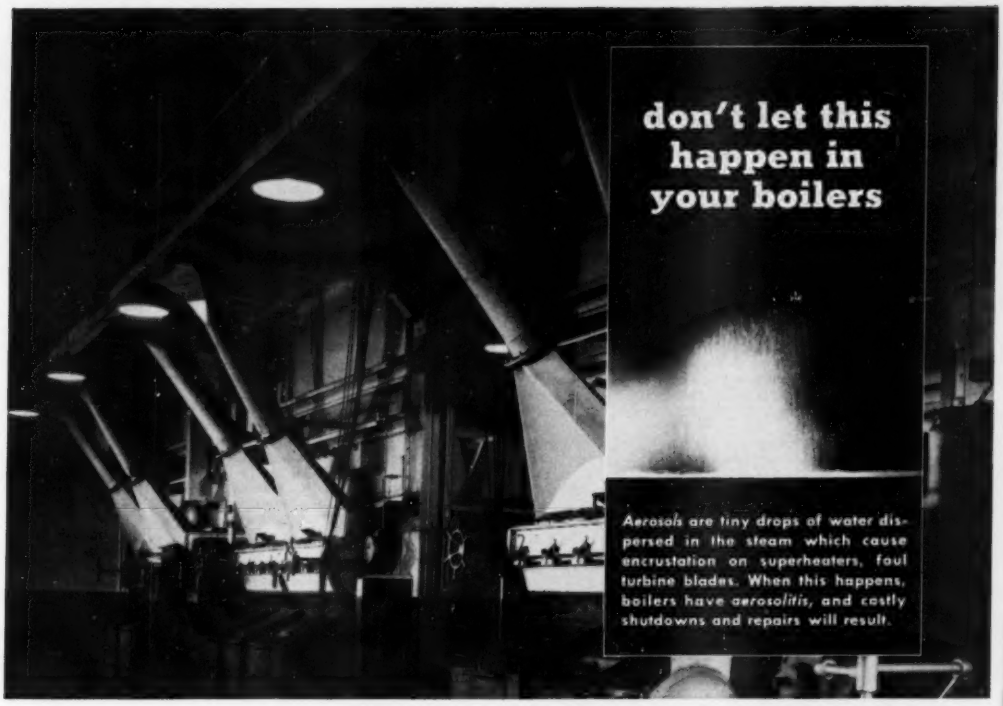
239 For Practical Men — That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and avoiding shutdowns. James G. Biddle Co.

240 Air Locks — Bulletin S-31, 2 pp, describing company's air locks and trip master controls for holding regulating and control valves in position during failure of air supply, is illustrated with photos, diagrams and line drawings. The Swartwout Co.

241 Flow Tubes — Catalog 80, 4 pp, presents engineering data on a new primary element for measuring, regulating and controlling fluid flow. Tells how these flow tubes are designed and how they function. Foster Engineering Co.

242 Control Equipment — General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pilot equipment. Simplex Valve and Meter Co.

(Continued on page 115)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Aerosols are tiny drops of water dispersed in the steam which cause encrustation on superheaters, foul turbine blades. When this happens, boilers have aerosolitis, and costly shutdowns and repairs will result.

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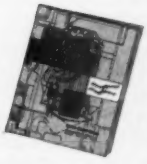

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POWER PLANT Construction News

Carlsbad, Calif. — San Diego Gas & Electric Co., San Diego, Calif., plans new steam-electric generating station in vicinity of Carlsbad, with turbine-generators, high-pressure boilers and auxiliary equipment for large rating. Cost reported close to $12,000,000, including transmission line to San Diego.

Etiwanda, Calif. — Southern California Edison Co., 601 West 5th St., Los Angeles, Calif., has approved plans for new steam-electric generating station at Etiwanda, near Los Angeles, initially projected several months ago, and will proceed with work at once. It will be equipped for a capacity of 250,000-kw, and is estimated to cost approximately $35,000,000. Completion is scheduled by close of 1952.

Denver, Colo. — Public Service Co. of Colorado, Inc., 900 15th St., plans expansion and improvements in local Lacombe generating station, with installation of a new 60,000-kw turbine-generator and auxiliary equipment. Work is scheduled for completion in about 24 months.

Harvey, Ill. — Ingalls-Shepard Division, Wyman-Gordon Co., Harvey, drop forgings for automobiles, airplanes, etc., plans extensions in power plant at local works, with installation of equipment for increased capacity. Cost reported close to $1,000,000. Schmidt, Garden & Erikson, 104 South Michigan Ave., Chicago, Ill., are architects. Main offices of parent company are at Worcester, Mass.

Elston, Ind. — Eli Lilly Co., Inc., 740 South Alabama St., Indianapolis, Ind., drug and pharmaceutical products, plans boiler house at proposed new plant at Elston, near Lafayette, where tract of land has been selected, fronting on Wabash River. Project will comprise several large units, and is reported to cost about $10,000,000.

Evansville, Ind. — Southern Indiana Gas & Electric Co., Evansville, has plans maturing for new steam-electric generating station on Ohio River near city, to be equipped for an initial rating of 40,000-kw, comprising turbine-generator of that capacity, high-pressure boiler and auxiliary equipment. Cost about $12,000,000, including transmission lines. It is scheduled for completion early in 1954.

Mishawaka, Ind. — Mishawaka Rubber & Woolen Mfg. Co., rubber footwear, a subsidiary of United States Rubber Co., 1230 Ave. of the Americas, New York, N. Y., plans new power plant at factory, reported to cost over $1,500,000, with equipment. Boddy-Benjamin Associates, Inc., 2210 Park Ave., Detroit, Mich., is consulting engineer.

Newburgh, Ind. — Southern Indiana Gas & Electric Co., Evansville, Ind., has tentative plans for new steam-electric generating station on Ohio River, near Newburgh, with 40,000-kw turbine-generator, high-pressure boiler and auxiliary equipment. Cost reported close to $12,000,000, with transmission lines, power substations and other operating facilities.

Richmond, Ind. — Municipal Lighting & Power Dept., 32 South 8th St., has plans maturing for new steam-electric power plant, reported to cost close to $3,000,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

Ford, Ky. — East Kentucky Rural Electric Cooperative Association, Winchester, Ky., has plans maturing for new steam-electric generating station in vicinity of Ford, representing part of a rural electrification project in that area reported to cost close to $30,000,000, including primary and secondary lines, power substations and other operating facilities. Financing has been arranged through Federal aid. Burns & McDonnell Engineering Co., 95th and Troost Sts., Kansas City, Mo., is consulting engineer.

Louisville, Ky. — Louisville Gas & Electric Co., 311 West Chestnut St., has acquired tract of over 250 acres of land on Ohio River, in vicinity of city, and will use as site for new generating station. Plant will have an initial capacity of 100,000-kw, and is estimated to cost about $15,000,000. It will be designed to accommodate five additional turbine-generators of same rating at later date, making a total capacity of 600,000-kw, with gross investment approximating $90,000,000.

Baton Rouge, La. — Naugatuck Chemical Division, United States Rubber Co., Elm St., Naugatuck, Conn., synthetic rubber, etc., plans boiler house at proposed new branch plant at Baton Rouge. Entire project reported to cost about $2,000,000. Work is expected to begin soon.

Lansing, Mich. — Municipal Utility Bd., Otto E. Eckert, general manager, plans extensions and improvements in municipal steam-electric generating station at Moores Park, including installation of new turbine-generator, boiler and auxiliary equipment. This will be part of a general expansion program for increased power facilities to cost about $20,000,000, scheduled to be carried out over period of several years.

Saginaw, Mich. — American Agricultural Chemical Co., 50 Church St., New York, N. Y., plans boiler house at proposed new commercial fertilizer manufacturing plant on tract of about 40 acres of land near Saginaw, recently purchased. It will comprise several one and multi-story buildings for processing and production. Work will begin soon. No official estimate of cost announced.

Aurora, Minn. — Minnesota Power & Light Co., Duluth, Minn., has plans maturing for proposed new steam-electric generating station on Colby Lake, near Aurora, to be equipped for an ultimate capacity of 200,000-kw, divided into several units. No official estimate of cost announced; it will represent large investment.

Jackson, Minn. — Federal Rural Electric Association, Jackson, plans expansion in power plant, including installation of a Diesel engine-generator unit, about 1230-kw rating, and auxiliary equipment. Financing in amount of $290,000 has been arranged through Federal aid.

Jefferson City, Mo. — Missouri Power & Light Co., 106 West High St., plans expenditure of about $9,000,000 for extensions and improvements in power plants, transmission lines, power substations and other operating facilities during next 30 months, concluding in 1953.

Newark, N. J. — Public Service Electric & Gas Co., Public Service Terminal, plans extensions in plants and system during next 48 months to cost approximately $100,000,000. Work will include expansion in generating station at Burlington, N. J., with installation of new 185,000-kw turbine-generator; additions to plant at Kearny, N. J., to accommodate two new 145,000-kw generators and auxiliary equipment; and extensions in station at Sewaren, N. J., with installation of new 125,000-kw turbine-generator and accessories.

Ithaca, N. Y. — New York State Electric & Gas Corp., Ithaca, will proceed with construction of new addition to Hickling steam-electric generating station, installation to include a new 50,000-kw turbine-generator and auxiliary equipment. Completion is scheduled next spring. Expansion also will be carried out at Greenidge steam-electric power plant, with installation of generators, high-pressure boilers and accessories for an increase of 100,000-kw in present rating. This project will be completed in 1953.

Purchase, N. Y. — Bd. of Directors, Manhattanville College of The Sacred Heart, Convent Ave. and 133rd St., New York, N. Y., plans power plant at new institutional buildings at Purchase (Westchester County) where tract of about 250 acres of land has been secured. Work will begin soon. Entire project is reported to cost about $14,000,000. Eggers & Higgins, 100 East 42nd St., New York, are architects.

Shelby, Ohio — Municipal Electric Dept., has plans for expansion in municipal steam-electric generating station, with installation of new 75,000-kw turbine-generator and auxiliary equipment. Cost reported close to $1,000,000. Emery, Marker & Emery, Toledo Trust Bldg., Toledo, Ohio, are consulting engineers.

Tipp City, Ohio — Municipal Light & Water Dept. plans extensions and improvements in municipal power plant, with installation of new Diesel engine-generator units and auxiliary equipment. Cost reported over $500,000. Proposed to carry out work in near future.

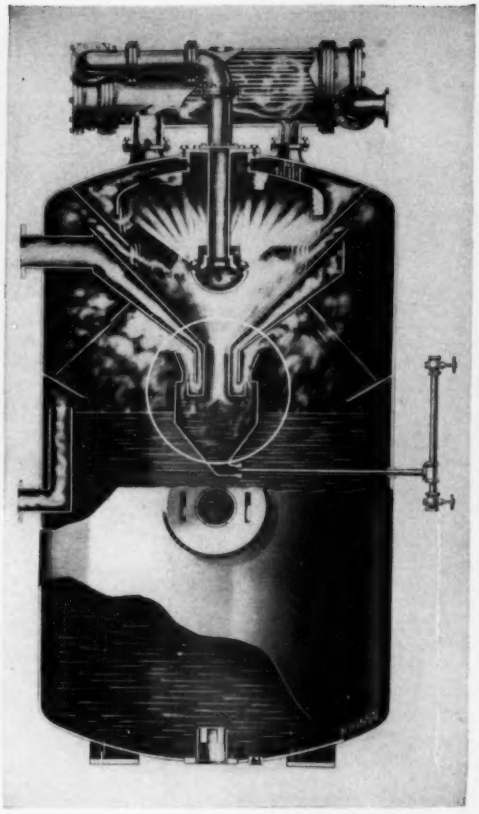
Warren, Ohio — General Refractories Co., 1520 Locust St., Philadelphia, Pa., plans boiler house at new silica refractories manufacturing plant at Warren, where tract of about 29 acres of land has been selected. Entire project is reported to cost about $3,000,000. Work is scheduled to begin soon.

Chickasha, Okla. — Public Service Co. of Oklahoma, Tulsa, has plans under way for new steam-electric generating plant in vicinity of Chickasha, with turbine-generators, high-pressure boilers and accessories for large capacity. Entire project reported to cost about $15,000,000, with transmission lines.

Dallas, Tex. — Dallas Power & Light Co., 1506 Commerce St., is arranging an expansion and improvement program in plants and system during next 36 months to cost approximately $27,500,000. Work will include completion of new generating station near city limits, to be equipped with turbine-generator of 80,000-kw rating, high-pressure boilers and auxiliary equipment, scheduled for completion in 1953. Also, power substations, transmission and distribution lines, and other operating facilities.

Fort Worth, Tex. — Castor Oil Products, Inc., 145 Alexander St., Yonkers, N. Y., plans boiler house at proposed new plant near Fort Worth, where site has been acquired. Factory will comprise several units, equipped for large output. Entire project is estimated to cost close to $2,000,000.

Salt Lake City, Utah — Utah Power & Light Co., Kearns Bldg., will make extensions in power plants and system during present year to cost about $16,000,000, including increased generating equipment, power substations, transmission lines and other operating facilities.



Hard scale, formed on the trays of deaerating evaporator preheaters, is no longer the big problem it used to be.

In a large central station (name on request), the preheaters had to be cleaned every three weeks, and the units were completely shut down at that time from eight to ten hours.

Then Worthington steam-jet deaerators were installed—with a "blowdown" head designed by Worthington engineers. This special head allows the operator to remove harmful deposits at regular intervals *while the unit continues in service*. It also provides for simple and speedy acid cleaning of critical parts, when necessary, without even opening an access door or removing any parts from the unit.

Compare The "Time-Outs"

The Worthington unit, given a short blowdown once each shift, stays in continuous operation with maximum deaeration for periods of at least 8 months. When the acid treatment is given at the end of that period, the job is finished in under three hours.

Compare this with the former record. *Then*—8 to 10 hours outage every three weeks and labor by a *crew* of men. Now—with Worthington's blowdown head—operation uninterrupted during regular short blowdown, with a shutdown for acid cleaning only once in almost a year, requiring only one man and three hours!

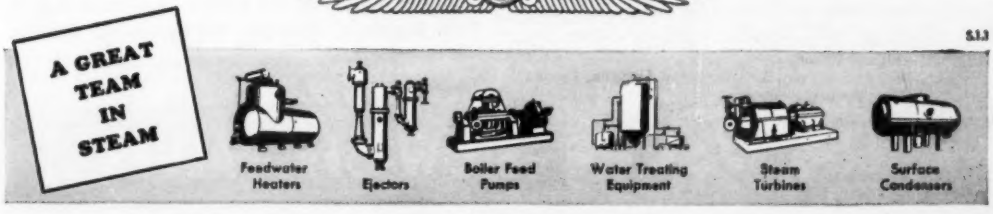
Worthington Makes Deaerating Equipment News

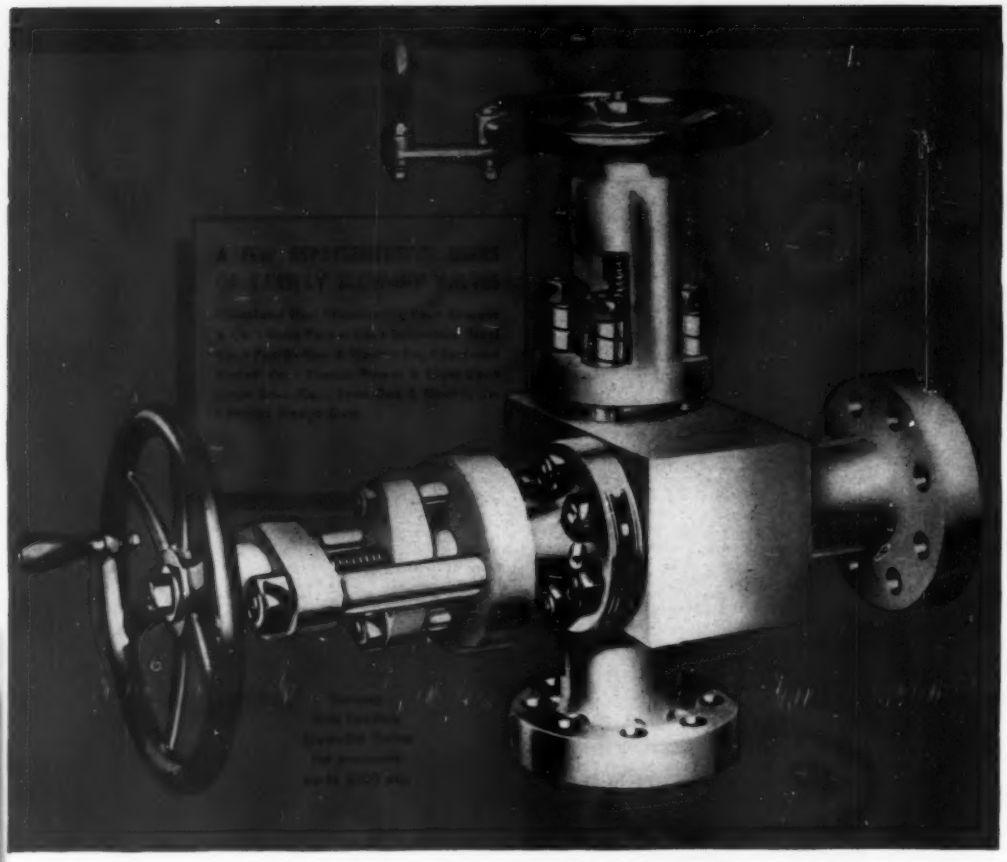
Developments like this, applicable to any deaerators operating under conditions of scaling, are typical of Worthington's engineering firsts in water treating and deaerating equipment.

Worthington manufactures all of the equipment needed in a complete water treating installation. For further information on why *there's more worth in Worthington*, address Worthington Pump and Machinery Corporation, Steam Power Div., Harrison, N. J.

WORTHINGTON

S-13





TIGHT! STRONG! for even toughest blow-down requirements

The Yarway Unit Tandem Blow-Off Valve meets the most demanding requirements for boiler blow-down or drain service.

It's drop-tight—and rugged enough to withstand the severe punishment of regular or emergency blow-down under pressure, or periodic acid wash.

Two Yarway Stellite-Seat Hard-Seat Valves or a Hard-Seat (blowing) and Seatless (sealing) Valve are combined in a one-piece forged-steel body. Designed for pressures up to 2500 psi.

It is significant that more than 4 out of 5 high pressure boiler plants use Yarway Blow-Off Valves.

For more facts, see Yarway Bulletin B-432.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY **BLOW-OFF VALVES**

LETTERS TO THE EDITORS

FLUORESCEIN

Some time ago we published a short article describing Detroit Edison Company's use of Fluorescein in the detection of small leaks between the condenser water boxes and the steam space. Fluorescein is a water-soluble dye that becomes fluorescent under the action of ultraviolet light. Since a number of readers were interested in applying this method they asked us where they might purchase Fluorescein. So we wrote to the Detroit Edison Company and received from Mr. Van Duzer the following letter. This letter tells where Fluorescein may be procured, so it should be of interest to other prospective users of this material.

ED.

FLUORESCEIN may be obtained from Eastman Kodak Co., Rochester, New York, as Fluorescein Sodium Salt No. T735 (technical) 500 grams for $5.00. We obtained our black light (ultraviolet) equipment from Switzer Brothers, 1220 Huron Road, Cleveland 15, Ohio, Model 108 Portable Black Light (spot). This equipment is complete and ready for use. Price, approximately $60.00.

Since one of your readers is in South America, another suggested source is International G. E. S. A., Inc.

Principal a Sta.
Capilla No. 6
Apartado 1666
Caracas, Venezuela.

You will find leaks using a concentration of from 5 to 10 ppm of Fluorescein. In one of our condensers holding about 300,000 lb of water, three pounds of the salt were used.

R. M. VANDUZER
Operating Engineer
of Power Plants.
Detroit Edison Co.
Detroit, Michigan

HYDROELECTRIC PLANT AT EILATH-SODOM FOR THE PRODUCTION OF MAGNESIUM

OWING TO the complete lack of our own petroleum oil resources, we are wholly dependent on foreign oil which is rather expensive. The price we are paying for electric power is much higher than that paid in any other country and wherever electric power is an important item in the cost of production, we are beyond any possibility of competition. The efforts and schemes already undertaken by Rutenberg Co., Prof. Laudermilk and others, namely to produce cheap hydroelectric power, have not succeeded in providing a profitable basis for industrial enterprise. In my humble opinion there are no brighter prospects for the most efficient and economical utilization of a waterfall in Israel than by linking Eilath with Sodom by means of a canal, thus creating with the least expenditure a potential difference in height of about 300 meters. (Approx. 1000 ft)

Furthermore, in view of the feverish activities for increased rearmament, there is a very distinct place for the production of magnesium metal which is very important for the aeronautic industry, being 35 per cent lighter than aluminum. It is no exaggeration at all to state that the most ideal spot in the world for the cheap production of magnesium on a large scale is located between the Red and Dead Seas, owing to their particular climatic and geographical properties.

The proposed annual capacity of the plant is estimated to be 2500 to 3000 million kwh at a cost of less than ½ U. S. cent. That whole power is primarily to be employed for the electrolytic production of metallic-magnesium from the magnesium chloride in the Dead Sea, which is estimated to contain at least 5000 million tons of magnesium metal.

The stream of salty water falling into the Dead Sea amounting to about 250 cubic meters per second, is figured out to be equal to the evaporation capacity of the Dead Sea area. On the other hand, the equivalent quantity of fresh water streaming continuously from the northern and eastern rivers are to be diverted by some appropriate means to irrigate the vast territory thirsty for water by means of decentralized power stations operated by centrifugal pumps and diesel motors.

I was glad to read that Israel was included in those countries which signed the Point 4 agreement with the U.S.A. It would be, therefore, very timely and advisable that the State Department in Washington consider urgently this idea, with the intention of setting up a special committee to study the proposed plan from all aspects and prepare a report on the matter that will include as well the recommendation for a financial undertaking for the mutual benefit of both countries — Israel and U.S.A.

J. MARSHAK
Petah, Tileva.
Israel

ABOUT ATOMIC ENERGY

FEW SUBJECTS have brought forth more discussion in engineering circles than that of using atomic energy. Engineers even remotely concerned with the generation of power are intrigued with the thought of unlimited power at low cost. Proponents of government-owned power plants acclaim it to be the answer to all power problems; the privately owned utilities regard it more logically. They do not feel that with the abundance of coal and oil in this country, atomic power would be able to compete with present day steam plants in the production of power.

It seems to be generally concluded that atomic energy cannot be utilized in small plants. There is a certain limiting size below which it is not possible to build a reactor — at least it would not be economical to do so. Even a small reactor needs a great deal of shielding.

It might be possible, however, to use atomic energy in a secondary form. It could be used in large plants to compress air or to liquefy certain gases. This compressed air or liquefied gas could then be stored in cylinders and distributed for use in small engines. It could also provide practically unlimited power for the production of liquid fuel from coal.

I assume that such matters are being considered so that if, and when, peacetime atomic power becomes a reality, the basic problems involved in such schemes will have been solved.

Pawling, N. Y. WILLIAM SHEFFER

Editor's Note:

Mr. Sheffer's point is perhaps a bit premature but it will do no harm to think about the ways in which we may be able to utilize atomic energy when peace-time atomic power plants become a reality.

This may not be so far off as some might think. As Mr. Sheffer points out, the utility companies are actively interested in atomic energy and, as announced by the Atomic Energy Commission recently, negotiations have virtually been completed with four groups of companies for expanded participation in reactor development. These groups include the Commonwealth Edison Co. of Chicago, The Union Electric Company of St. Louis, Mo., The Pacific Gas and Electric Co. and the Detroit Edison Co.

There is a point about the use of atomic energy by utilities that is not generally understood and that is that with present military requirements for fissionable material, economics need play only a very small part in the picture as a whole. For example, suppose the utilities with the cooperation of the AEC build reactors which would have, as their primary purpose, the production of plutonium for military use. These reactors, at the same time would evolve tremendous amounts of heat which could be utilized to generate electricity. Thus, the utilities would operate the reactors, using atomic fuel supplied by the AEC. The utilities would distribute the electric power so generated and the resultant plutonium or other fissionable material would be delivered to the AEC for military purposes. Cost of fuel would have no more bearing on the operation of such reactors than it has now in the operation of the great plutonium reactors at Hanford, where, now, the heat evolved in the process is wasted.

More Power For Cedar Falls

Although built as an extension to an old plant the new 5000-kw turbine-generating unit and 60,000 lb per hr boiler virtually constitutes a new plant—the first part of a long range plan to assure the power supply of Cedar Falls, Iowa. The boiler was made slightly larger to accommodate outside steam requirements to City's water gas plant and several heating customers. Boiler is fired by spreader stoker and is designed for 400 psig, 750 F operation

By R. H. SOGARD
Stanley Engineering Company
Muscatine, Iowa

THE CITY OF CEDAR FALLS, Iowa in September 1950 placed in service a much needed addition to its long established municipal electric generating plant. A 5000-kw turbine-generator unit was started, the running mate of a 60,000 lb per hr boiler unit that was put into service late in 1949. Wartime load growth, without equivalent capacity increase being possible, had been seriously taxing the previously existing generating facilities.

Background

Cedar Falls is a farm center and industrial town of 15,000 in the east central part of Iowa and some seven miles from Waterloo, which is a large food processing and tractor producing center. Cedar Falls also has the only state teacher's college in Iowa, and one of the largest in existence.

The municipal electric plant was begun in 1914 with a $75,000 bond issue. Initial generating units were driven by two Corliss engines that did yeoman service until 1930. During this period two Diesel units were added, one of 525 kw in 1924 and another of 850 kw in 1927.

In 1930 the two steam engines were replaced by a 1500-kw turbine unit, and a 2500-kw machine was added in 1937. Boiler capacity was installed in a 360-hp boiler in 1925 and two 412-hp boilers in 1930. All of this equipment was for 200 psig-500 F.

A modern hydroelectric plant of two 600-kw units was built in 1940 to utilize an existing dam on the Cedar River near the north end of town.

Thus at the beginning of the last world war, the City had 6575 kilowatts in nameplate capacity: 4000 kw steam, 1375 kw Diesel, and 1200 kw hydro. However, the hydro was largely run-of-river, with not too much firm power, and regular use of the Diesels was more expensive than steam and not always adequate. The result was that by the end of the war, load growth was severely crowding generating capacity, which it had not been possible to enlarge during the war.

Design Considerations for New Addition

In order to realize most of the time the benefits of higher steam conditions and of considerably better boiler efficiency, it was decided to size the new equipment to handle the existing entire load. Present equipment would initially serve as standby and later to help carry the peaks when these would grow beyond the capacity of the new equipment. Accordingly a 5000-kw turbine-generator was selected. A 60,000 lb per hr (continuous rating) boiler, although slightly oversized for this turbine, was chosen because of outside steam requirements to the City's water gas plant and to two heating customers.

While fuel economy called for steam pressure and temperature for the new equipment to be higher than those existing, the size of the new installation and the desire to hold down investment indicated that 400 psig-750 F were desirable throttle conditions.

The flexibility, adaptability to this size boiler, and versatility with different fuels that are possessed by the spreader stoker made it the logical fuel firing equipment to use. Since this was to be a base load unit, automatic combustion control was installed for the fuel economy obtainable.

In addition to the usual considerations, certain local conditions applied to this plant addition. In brief, it was equivalent to building a new plant which, nevertheless, had to be integrated with the old plant. A new pattern was being set, as the old plant

Fig. 1. General view of the new 60,000 lb per hr, 400 psig, 750 F, boiler, showing the spreader stoker

was quite out of date. The new addition is the first part of a long range plan, which by means of further additions, will constitute a modern plant to replace the old one.

A new coal handling system had to be installed to meet the greater requirements of the new boiler and to deliver coal to the higher bunker. The steam output of the new boiler had to be connected to the header of the old plant through a pressure reducing-desuperheating station, to permit operation of the old turbines by the new boiler.

The parallel connection of the deaerating heater with two 5 psig outside heating customers called for the use of 5 psig constant pressure in this feedwater heater. The old boiler room had a deaerator sized for the old boilers, but to avoid the complications of operating two constant pressure deaerators in parallel, the new

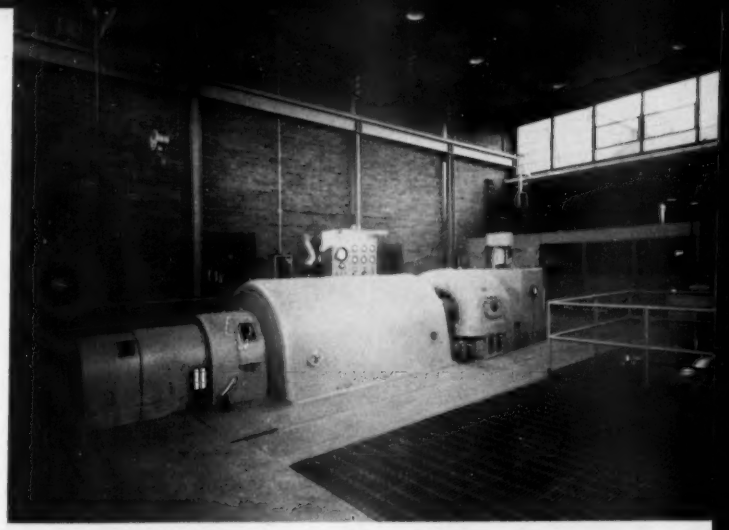


Fig. 3. The turbine room showing the new 5000-kw turbine generating unit. This turbine is equipped with extraction control valves to furnish steam to a 5 lb heating system

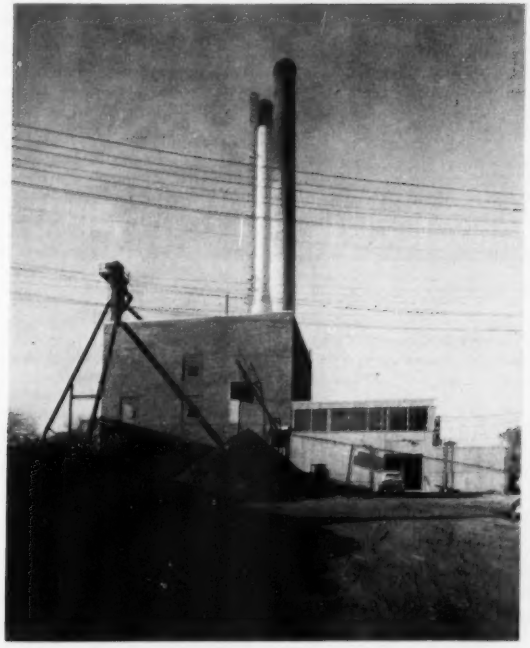


Fig. 2. A view of the south end of the plant. The new boiler, turbine and auxiliaries are housed in this addition to the old building at the south end, not visible in this picture

one was made large enough to handle both old and new boilers.

The requirement for 5 psig steam varies considerably, the space heating portion varying with the weather and the feedwater heating portion varying with electric load. As the total 5 psig requirement is low much of the year, it was not found economical to use all steam driven auxiliaries on the boiler, but to limit these to the boiler feed pumps. To meet large 5 psig steam requirements in cold weather, a sequential pressure control system utilizing turbine extraction steam to the fullest was installed, backed up by use of high pressure steam as required at low turbine load.

A basic source of 5 psig steam is boiler feed pump turbine exhaust. The inherent inefficiency of these small turbines provides relatively constant exhaust flow at varying load. The balance of the 5 psig steam is provided by three pressure reducing valves in parallel. The first of these is connected to the 8th stage of the turbine, and this valve opens until all available steam is being taken from the 8th stage. When this is inadequate, the second control valve — connected to the 4th stage of the turbine — opens and provides 5 psig steam as required. Should still further 5 psig steam be required, a third control valve which is connected to the 400 psig line is opened. All three control valves are air operated by a master control, which is connected to the 5 psig header. The individual extraction control valves also respond to reduced extraction pressure, closing when the extraction pressure becomes lower than 10 psig, as an additional safeguard against backflow into the turbine. The extraction lines are also provided with the customary nonreturn valves, air operated by the throttle trip and free to swing shut by reverse flow.

All of the 5 psig space heating steam is desuperheated before use, as its temperature can rise to as much as 650 F, depending upon its source.

Another local condition involved high ground water. Although the Cedar River is some 1000 ft distant, its flood waters have reached almost to the level of the plant operating floor. One provision against flotation was made with an unusually heavy basement floor. A second precaution is a ground water collecting system outside the basement walls, which drains to a cistern that in turn is emptied by a float controlled pump.

To increase distribution system capacity with the existing copper, the primary voltage was raised from 2400 to 4160. The new generator was connected for 4160 v. Unfortunately, one of the two older turbine driven generators, and both Diesel engine-generators, all rated at 2400 v, could

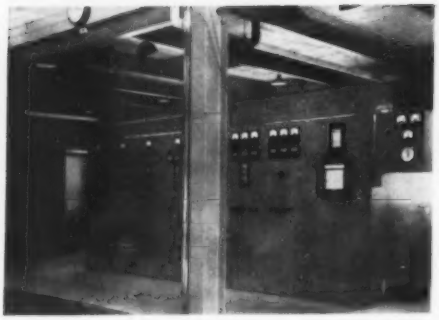


Fig. 4. The new electrical switchboard

not be reconnected for 4160. Therefore a 2400/4160 v tie transformer of 5000 kva capacity was installed.

New Structure

The new boiler, turbine and auxiliaries are housed in an addition to the older building at its south end. The new boiler room is of brick and although it enclosed the existing concrete stack, the new boiler was not connected thereto, but rather to a new and individual self-supporting steel stack. The new turbine room has brick on its permanent wall and corrugated asbestos siding on the temporary end.

The new brick building and the new self supporting steel stack are shown in Fig. 2. This also shows the old concrete stack behind the new one. The old building is not visible in this picture. The bucket elevator which delivers the coal to the upper part of the boiler house can be seen at the left of the building.

The operating floors for both boiler room and turbine room are a few inches above ground level. The bottom of the existing concrete stack foundation was above the new basement floor level in both the turbine room and the boiler room. It was therefore necessary to construct a retaining wall around the stack foundation. This was successfully accomplished, the stack showing no tipping or other distress.

New locker room facilities and a new plant office were constructed as part of the turbine room addition. New section of the plant is shown in Fig. 5.

New Equipment

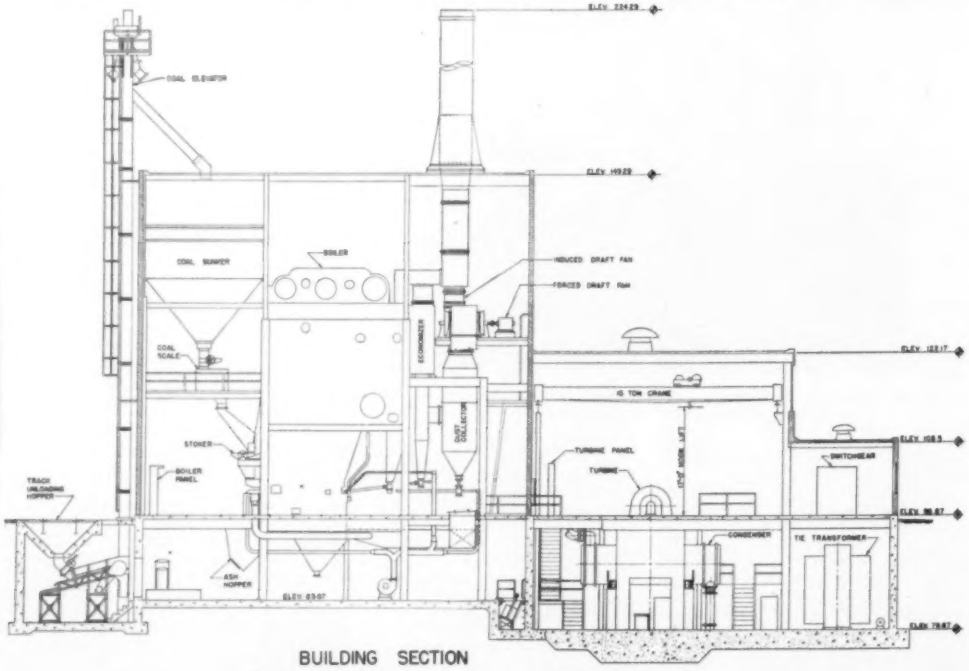
Coal burned is principally from central Illinois. It is received by rail, dumped into a track hopper and delivered by an apron feeder to a bucket elevator. By gates at the head terminal, the coal is delivered to one of two chutes for stocking out in the yard, or to the 112 ton boiler room bunker. Reclaim from the yard is through the same track hopper.

From the bunker, coal passes through a belt type coal scale and non-segregating spout to the stoker hopper.

The stoker installation is designed to handle 1½ in. screenings with 13 per cent moisture, 15 per cent ash, and 10,000 Btu as fired. A dust collector and reinjection system is provided, the latter handling refuse from hoppers under the boiler last pass, the economizer and the collector. The furnace is equipped with water walls on the side and rear walls, while the front wall is made up of sectionally supported tile.

The boiler is equipped with complete instrumentation and air operated combustion control, all mounted on a 90 in. high by 54 in. wide panel. The combustion control includes elements and actuators for fuel feed (stoker variable speed drive), air flow (forced draft fan inlet vanes), and furnace draft (induced draft fan hydraulic drive).

Ash handling for the new boiler is cared for by extension of an existing



BUILDING SECTION

Fig. 5. Section through the new building showing arrangement of equipment

monorail and tipping bucket system, at very little cost. It was felt desirable to delay the installation of a new ash handling system until a second new boiler is installed.

The turbine-generator is an orthodox handbook unit, 5000 kw, 0.8 pf, 3600 rpm and with three extraction points. The lowest of these three serves a closed heater, at sub-atmospheric pressure, in the customary fashion. The medium and high pressure points, plus a main steam connection, are tied through the previously described sequential pressure control system into a 5 psig steam header. This arrangement, while unconventional in comparison with the standard closed heater cycle employed in a straight steam-electric plant, is the best solution for meeting local 5 psig steam requirements. The automatic sequential control system has worked out well in actual operation.

The surface condenser is bolted rigidly to the turbine exhaust flange, but is also supported by springs at four points. A manhole in the condenser neck provides access to the exhaust space and to the inside bolted flange, since the openings in the turbine exhaust hood are merely armholes.

Circulating Water From Deep Well

Circulating water is currently obtained from a well a few feet from the turbine room wall, a vertical deep well pump with a 70 ft setting being used. The low and constant temperature of the water, 51 F, enables the use of only 3000 gpm in three passes through the condenser. Should the well supply become inadequate in the future, the condenser can be changed to single pass operation (by removing division plates in the water boxes), when it will handle 10,000 gpm of 85 F water. An existing large pond next to the plant will permit use of sprays, or a cooling tower might be used. The circulating water piping is so arranged that two horizontal circulating water pumps may be installed and readily connected to flanges now blanked off.

New 4160-v, 3-phase, 4-wire, 250,000-kva switchgear was installed along the east side of the turbine room addition. The new switchgear includes circuits for the new generator, a station power transformer bank, outgoing feeders and the 4160/2400 v tie transformer to the old bus and board.

To serve two rural lines, a new 1500-kva, 4160/12,470-v unit substation was installed just north of the plant. It is of metal-clad weatherproof construction, with 125-v, d-c operated 150,000-kva air circuit breakers. The outgoing feeders from the substation distribute at 12,470/7200 v. The substation is arranged for future extension.

The underground circuits from the plant to the unit substation and to terminal overhead structures are carried in a water-tight concrete trench system, which has gasketed manhole covers. This system is arranged to withstand floods slightly above grade.

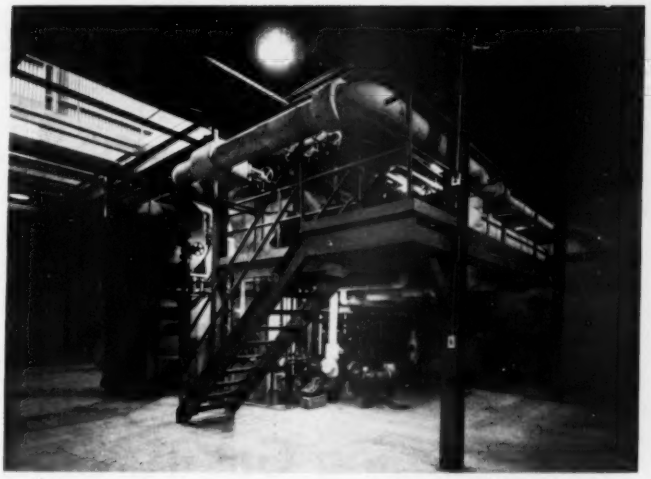


Fig. 6. Gallery in turbine-room basement carrying the air ejectors and extraction heater

The management of the Cedar Falls municipal utilities, which include manufactured gas, electricity, water and sewage services, is under the mayor and the city council. The superintendent of utilities is Henry F. Beisner and the engineer-in-charge of the electric plant is Newell Fairburn.

Design of the new installation and supervision of its construction were by the Stanley Engineering Company of Muscatine, Iowa.

LIST OF PRINCIPAL EQUIPMENT

Boiler—Murray Iron Works, 4-drum, bent tube, 450 psig, 7965 sq ft in boiler, 956 sq ft water walls, 2960 cu ft furnace volume, 60,000 lb per hr continuous, 72,000 lb per hr 4 hr peak, 83.4 pct effic.

Superheater—Foster Wheeler, 450 psig, 750 F, 1625 sq ft, 4-loop bare tube.

Economizer—Foster Wheeler, 500 psig, 5544 sq ft, extended surface.

Mechanical Draft—FD Fan: Amer. Blower, No. 330, DW, inlet vanes, 1170 rpm, 30 hp motor. ID Fan: Amer. Blower, No. 6 Sirocco, DI, 2/3 DW, hydraulic drive, 1170 rpm, 125 hp motor.

Sootblowers—Diamond Power Specialty Co.

Dust Collector—Western Precipitation Corp. No. 6-72.

Instruments and Combustion Control—Republic Flow Meters Co.

Stoker—Detroit Stoker Co. Roto-grate, 133.4 sq ft, travelling grate, 1½ hp motor drive, steam turbine standby drive for rotors.

Coal Handling—Fairfield Engineering Co., 35 tons per hr, track hopper, apron feeder, bucket elevator.

Coal Scale—Stock Equipment Co., 200 lb.

Turbine-Generator—General Electric Co. 400 psig, 750 F, 2 in. abs. exhaust, 5000 kw, 6250 kva, 0.8 pf, 4160 v, 3600 rpm, 125 v 40 kw exciter.

Condenser—Elliott Company, 4000 sq ft, 16 ft tubes, phos. Admiralty, 3 pass, 3000 gpm, 60 F, 1 pass 10,000 gpm, 85 F.

Condensate Pumps—Elliott Co., 125 gpm, 145 ft tdh, 1750 rpm, 15 hp motors.

Extraction Heater—Ross Heater and Mfg. Co.

Circulating Pump—Pomona deep well, 70 ft head, 3000 gpm.

Hot Process Softener and Filter—Cochrane Corp., 2400 gph.

Deaerating Heater—Cochrane Corp., 5 psig steam pressure.

Low Pressure (Steam) Sequential Control System—Fisher Governor Co.

Switchboard, Switchgear, and Instruments—General Electric Co. metal-clad, 4160 v, breakers 125 v d-c operated.

Tie Transformer—General Electric Co., 5000 kva, 2400/4160 v.

Unit Substation (Outdoor)—General Electric Co., 4160 delta/12470 v Y, metal-clad, 15,000 v air circuit breakers, 125 v d-c operation, 150,000 kva interrupting capacity.

Boiler Room Building—Jens Oleson & Son, Waterloo, Iowa.

Boiler Room Mechanical—Industrial Heating and Plumbing Co., St. Joseph, Mo.

Turbine Room Building and Mechanical—Winger Construction Co., Ottumwa, Ia.

Electrical—Industrial Electric Co., Minneapolis, Minn.

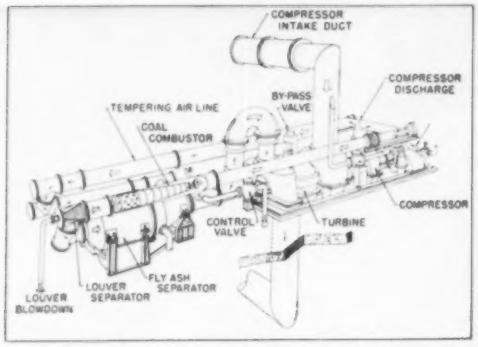


Fig. 1. LDC experimental Houdry coal-burning gas turbine that has been operated 1000 hr on coal in test operation during past year

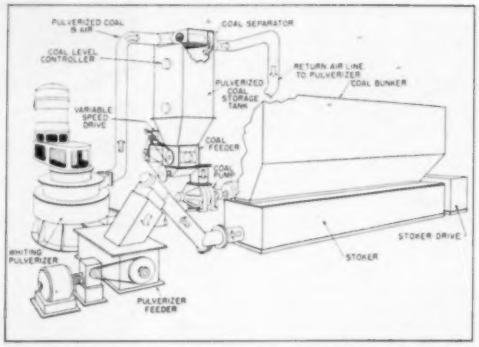


Fig. 2. Coal-handling system for the LDC experimental gas turbine; coal first put under pressure at coal pump

Coal-Burning Gas Turbine Steps Ahead

A Progress Report

By JOHN I. YELLOTT Director of Research, Locomotive Development Committee

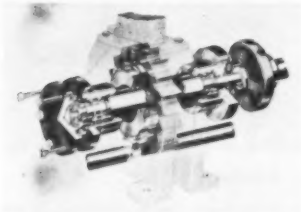


Fig. 3. Coal pump details; compressed air line at bottom removes pulverized coal from pump pocket, transports it to combustors

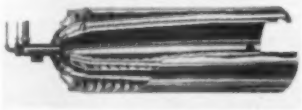


Fig. 4. Flame tube

Fig. 5. LDC annular burner, sectional view

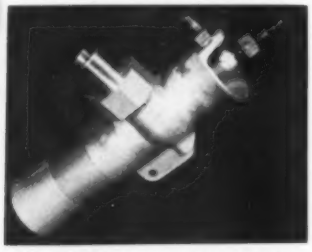


Fig. 6. LDC annular burner, exterior view

Locomotive Development Committee's experimental Houdry gas turbine, during past year, has completed 1000 hr of coal-fired operation . . . As a result of successful tests early in 1951, a 4200-hp Allis-Chalmers locomotive-type turbine has been erected at Dunkirk, N. Y. and will soon be in operation on coal . . . This article* shows how most of the problems in coal preparation and feeding, ash separation, blade erosion, have been solved during past year's work with experimental turbine . . . Results very encouraging for early operation of the locomotive turbine

THE LOCOMOTIVE Development Committee gas turbine is a typical Houdry process oil refinery unit, lent to the Committee by the United States Bureau of Mines. As Fig. 1 shows, the unit has been erected with a twin combustion system. Coal combustion and ash removal equipment is located in one of the two compressor discharge lines, while an oil combustor is located in the other. This arrangement enables the unit to be started on oil, and then switched over to coal after it is up to speed. In operation, the oil combustion system was used for tempering the 1300-F air coming from the coal system. The Houdry turbine is limited to an inlet temperature of 950 F, so the coal-heated air was "cooled" by oil-heated air.

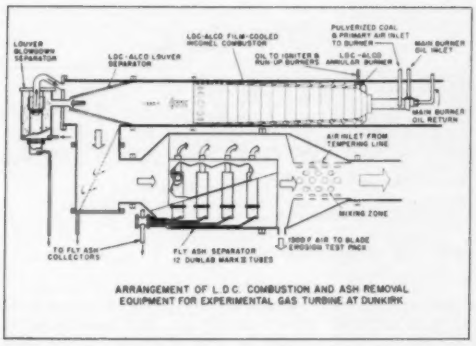
Coal Preparation and Feeding

The coal preparation system, Fig. 2, has undergone few changes during the past year. Fundamental principle of the LDC coal-fired gas turbine system involves preparation and feeding of the coal at atmospheric pressure, since that is the only pressure which remains constant in a variable-speed gas turbine cycle. A rotary coal pump, Fig. 3, continuously transfers the pulverized coal as it comes from the feeder to a compressed air line which conveys the coal to the combustor. The pulverized coal storage tank is kept full by a coal level controller, which regulates the admission of coal to the high-speed impact mill. Supply of coal from bunker to mill is in turn regulated by a second level controller, which keeps the mill supply tank filled.

Major problem encountered in the operation of the coal-handling system was development of a satisfactory feeder. After trying various types of close-clearance feeders with metal rotors, a new feeder was constructed with rotors made of rubber oil pump elements. This feeder has proved to be quite satisfactory, and the difficulties of leakage, plugging, etc., appear to have been overcome. Several types of variable speed drive have been tested, and it has been found that the rubber rotor pump can be controlled accurately by a 1-hp Vickers drive. This drive, which is remotely controlled by the plant operator, constitutes the throttle of the system.

Combustor Development

Combustor development has continued to yield encouraging results. The arrangement used in most of the Houdry unit tests is shown in Fig. 7. The flame tube itself, Fig. 4, is the


LOUVER BLOWDOWN SEPARATOR
LDC-ALCO LOUVER SEPARATOR
LDC-ALCO FILM-COOLED INCONEL COMBUSTOR
OIL TO IGNITER & RUN UP BURNERS
PULVERIZED COAL & PRIMARY AIR INLET TO BURNER
LDC-ALCO ANNULAR BURNER
MAIN BURNER OIL INLET
MAIN BURNER OIL RETURN
AIR INLET FROM TEMPERING LINE
MIXING ZONE
1300 F AIR TO BLADE EROSION TEST PACK
TO FLY ASH COLLECTORS
FLY ASH SEPARATOR 12 DUNLAB MARK II TUBES

ARRANGEMENT OF L.D.C. COMBUSTION AND ASH REMOVAL EQUIPMENT FOR EXPERIMENTAL GAS TURBINE AT DUNKIRK

Fig. 7. Houdry unit combustion-ash removal system. Same principles to be used for Allis-Chalmers unit, Fig. 15

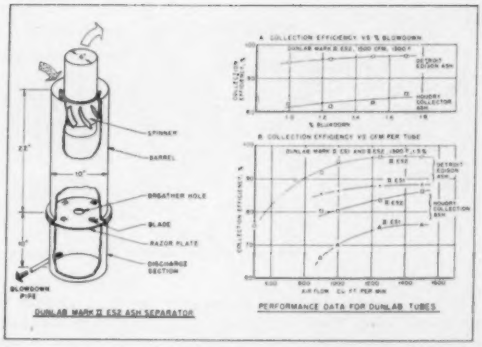


Fig. 8. Dunlab tube at left. At right: A — Collection efficiency vs per cent blowdown; B — Collection efficiency vs air flow

Fast in 1950 and 1951

result of a three-way experimental program. Various types of film-cooled, all-metal combustors were tried simultaneously. The design shown in Fig. 4 consistently reached 95 per cent combustion efficiency with high-volatile coal, while metal temperature remained low enough to give a satisfactory life to the flame tube. Proper selection of air slot width resulted in acceptable cleanliness, while adequate range has been reached by combining the flame tube with the LDC annular burner shown in Figs. 5 and 6.

One of the original requirements called for a combustor which could burn either oil or coal. The LDC combustion team at Dunkirk, under the direction of F. D. Buckley, devised the annular burner shown in Figs. 5 and 6. A Peabody wide-range burner was chosen as the central element, since experience had shown that this type of burner operated satisfactorily under gas turbine conditions. The configuration of the combustor required the coal-air stream to enter at right angles to the axis of the combustor. After encountering difficulties in trying to distribute the coal evenly from various types of multi-jet burners, the Dunkirk group made a virtue out of this difficulty by using a tangential coal entrance, thus giving a swirl to the coal-air stream as it emerged from the burner. Vanes in the flame tube provide a swirl in the opposite direction for the secondary air, thus giving the turbulence essential to good combustion.

Ash Separation

The all-important problem, however, is ash removal. Virtually all of the plus-20-micron ash must be removed if the turbine blades are to have a life approaching commercial requirements. Most important accomplishment of the 1950–51 LDC program was the development of a fly ash separator which could operate successfully under gas turbine conditions and give a collection efficiency high enough to afford adequate protection to the turbine blades. Prior to the beginning of the LDC program, there had been no commercial experience with separators operating under high pressures and temperatures up to 1300 F.

Most serious problem was the burning of the separators by the carbon remaining in the ash from low-efficiency combustion. This problem was overcome by the two-fold method of improving combustion efficiency to reduce the carbon in the ash and developing continuous blowdown systems to discharge the ash as rapidly as it was produced.

Test Programs

The most significant work in the fly ash program consisted of four 250-hour test programs in which approximately 1000 lb of 10-per cent ash coal were burned per hour. In the first 250-hr program, a battery of 18 straight-through separator tubes was employed. These tubes discharged most of the ash in a 10 per cent blowdown stream. It was found that the collection efficiency in the plus-20-micron size range was not high enough to protect the turbine. Changes in the tube arrangement during the second 250-hr test also failed to produce the desired results, and a new separator was constructed, which used 18 Type 10 VSX Multiclones. These tubes were arranged in two banks of nine tubes each, with ash removal provided by a trough and screw at bottom of each bank.

Fig. 9. Erosion on first cylinder row of Houdry turbine after 250 hr

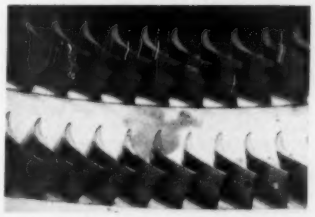


Fig. 10. Erosion pattern after third 250-hr test: 1 — First Row; 2 — Second Row

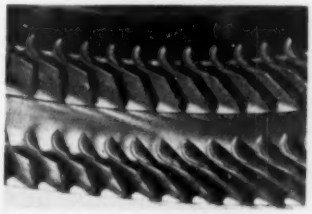


Fig. 11. First two cylinder rows after fourth 250-hr test, Houdry experimental unit, after removal of plus-20-micron dust by revised separators

Fig. 12. Rotor blades, 1000 hr, Houdry experimental unit

* Prepared by the author especially for POWER ENGINEERING and based on his progress report delivered before the 13th Annual Midwest Power Conference at Chicago, April 6.

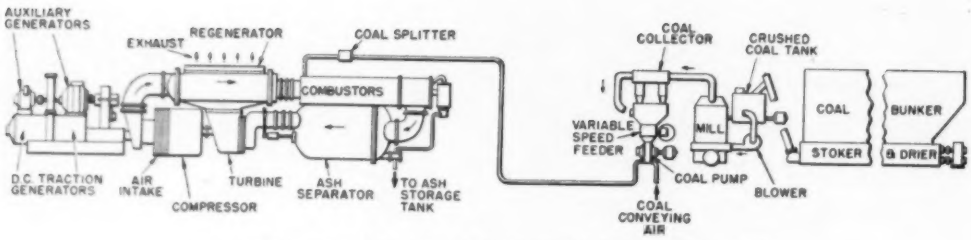


Fig. 13. Schematic diagram of arrangement for Dunkirk test of Allis-Chalmers locomotive turbine

Although the tubes individually operated with good efficiency, the battery of tubes was virtually ineffective. The cause for this difficulty was traced to recirculation in the discharge troughs.

When it became evident early in 1950 that the commercially available separators would not do an adequate job for gas turbine operation, a separator development program was undertaken in the Dunkirk laboratory.

Intensive study of the separator literature showed that excellent results had been reported from Vienna by Feifel. His separator differed from American designs in that it used an iris diaphragm with a second hole near the wall of the tube. A spinner at the inlet of the tube caused the air and dust to rotate, throwing the dust toward the wall of the tube. The dust and some of the air passed through the peripheral hole into the dust bin, where the dust was deposited, while the air returned through the central hole.

A study of the American patent literature showed that this idea dated back at least to 1904. The LDC "Dunlab" tube took the form shown in Fig. 8.

The LDC tests, Fig. 8, were run with two types of ash. The first was procured from The Detroit Edison Co., of which 69 per cent was finer than 40 microns (325 mesh), and 20 per cent was finer than 10 microns. (25,000 microns equal one inch.) Other tests were run with ash collected from the Houdry operation, with 85 per cent less than 40 microns and 49 per cent less than 10 microns.

Efficiency of the tube was found to be relatively independent of the amount of air discharged through the blowdown pipe.

After the third 250-hr test of the Houdry unit, when blade erosion was still a most serious problem, the Multiclone tubes were modified to incorporate the features of the Dunlab tube. To make certain that there could be no recirculation among the tubes, each blowdown line was carried through a separate nozzle into a discharge header, and pressure drop was measured across each nozzle to make sure that the tubes were operating properly. Tests of this system showed that virtually no ash larger than 20 microns was getting to the turbine, consequently a fourth 250-hr test period was run with the Houdry turbine. Results of this test were so encouraging that a similar separator has been constructed for use with the Allis-Chalmers locomotive turbine.

Blade Erosion

During the four 250-hr test periods, blade erosion was studied with great care. It was found after the first 250-hr period that the erosion was restricted almost entirely to the cylinder blades, while the rotor blades remained virtually unaffected. In the first cylinder row, the erosion was restricted to the trailing edges of the blades and to a zone extending inward about one inch from the tips of the blades. The erosion pattern can be seen clearly in Fig. 9, taken after the first 250 hr. The lashing wires, used to give stiffness to the first blade row, caused formation of double vortices. These vortices operated like miniature milling cutters and produced severe localized erosion. The second row, in the same segment, was virtually undamaged, since the ash stream passed part way around the turbine in going through the first rotor row. Damage was caused to the second cylinder row midway between the tips and the roots. In the remaining rows, the damage was restricted to erosion of the trailing edges near the roots of the blades.

After 500 hr, the first two rows of blades were renewed. Fig. 10 shows the erosion pattern which was found after the third 250-hr test, when the turbine had been exposed to a relatively heavy flow of plus-20-micron ash. The lashing wires were omitted from the first cylinder row during this test, hence the twin pattern of Fig. 9 is not in evidence.

Damage to the rotor blades during the first 750 hr was very slight. The last four rows showed virtually no effects aside from a slight thinning at the blade tips, and occasional nicks or dents caused by the passage of a large object. The first row of rotor blades suffered some damage during the third 250-hr test, and they were replaced prior to running the fourth and successful test.

The revised separator, Fig. 7, removed virtually all of the plus-20-micron particles, and only about 10

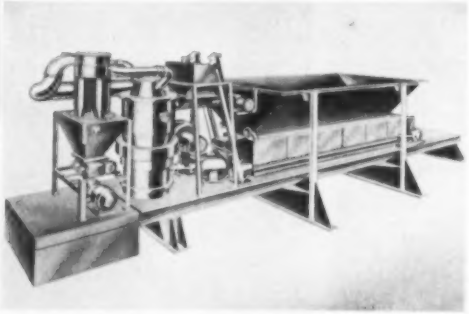


Fig. 14. Coal-handling system for Allis-Chalmers locomotive turbine now being erected at Dunkirk

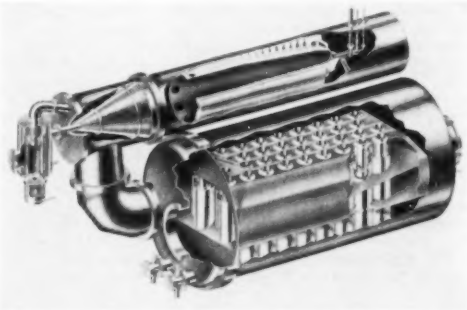


Fig. 15. Cut-away view of combustion and ash-removal system to be used in Allis-Chalmers turbine similar to that of Fig. 7

per cent of the dust entering the turbine was larger than 10 microns. Dust of this nature appeared to be relatively harmless, as Fig. 11 indicates.

The rotor blades are shown in Fig. 12. The first row, with 250 hr of service, is as good as new, and the remaining four rows have undergone only an inconsequential amount of erosion.

It may be concluded that removal of virtually all of the plus-20-micron dust puts an end to blade erosion under the operating conditions of the Houdry turbine.

Locomotive Turbine Test Plant

The Allis-Chalmers locomotive-type turbine, Figs 13 to 17, has been installed at Dunkirk within the space limitations imposed by railway clearances.

Approximately 18 tons of coal can be carried in the bunker, which will be supplied at Dunkirk by means of a screw conveyor from a larger coal supply located outside of the test building. The coal is dried and partially crushed in a special stoker designed and built by The Standard Stoker Co. (now Read Standard Corp.). The coal is delivered by two elevator screws to a crushed coal storage tank. The crushed coal tank is kept full at all times, a level indicator being used to start and stop the stoker drive. The pulverizer is a special two-row Babcock and Wilcox mill, designed to operate under full gas-turbine pressure, if necessary. The pulverized coal is transported from the mill to the coal collector by air supplied by a 3000-cfm blower.

After the pulverized coal is stripped from the conveying air, most of the air is returned to the blower inlet. A small quantity of air is vented from the system to keep it in equilibrium, and an equivalent amount of makeup air is drawn into the blower inlet. The delivery of coal to the pulverizer is controlled by a level indicator in the pulverized-coal storage tank. A standard Bailey mill level controller is also used to prevent the mill from being over-supplied with coal.

A twin-drum Rotolock feeder, built by the Omega Machine Co. of Builders Iron Foundry, will be used in the first tests. This will be driven by an Oilgear variable-speed hydraulic transmission. The speed-control lever on the pumping element of the Oilgear will be the throttle of the entire power plant. This lever is actuated by a Hagan power unit, which can in turn be remotely controlled by either manual or automatic means. The feeder will discharge into a standard LDC coal pump, from which a stream of compressed air will carry the coal through a splitter to the twin combustors.

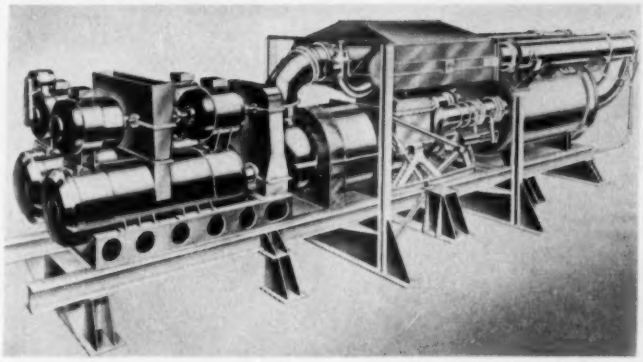


Fig. 16. General arrangement of Allis-Chalmers coal-burning gas turbine power plant for locomotive

In the test operation at Dunkirk, all the auxiliaries, with the exception of the feeder, are driven by 220-v, 60-cycle a-c. After the power plant has been tested, the power for the auxiliaries will be supplied by two 175-kw alternators driven from the main reduction gear.

Air required to convey the coal from pump to combustors will be supplied by a small Standardaire booster compressor. This compressor will take air from the main compressor outlet and add the pressure necessary to overcome the drop through the pump and the coal conveying line. Use of a positive displacement compressor as the booster will result in the coal-air ratio remaining virtually constant at approximately 1 lb of air per lb of coal.

A regenerator of approximately 50 per cent effectiveness is used to preheat the compressed air before it enters the combustion system.

A reduction gear is used to reduce the turbine speed, 5700 rpm, to 2000 rpm for the traction generators. Additional pinions in the gear system drive the two a-c auxiliary generators as well as an exciter and a d-c auxiliary generator. In normal service, the frequency of the a-c will vary from 66 cycles at maximum speed to 40 cycles at idling.

The entire plant will be under the control of a single operator stationed at the turbine control panel.

As soon as the initial operating difficulties have been overcome, the unit will be run for approximately 500 hr at varying loads to determine the effect upon the turbine blades of 1300-F air containing minute dust particles. The blades of the locomotive turbine are made of S-590, one of the best available high-temperature alloys. This material is considerably harder than the Houdry blade alloy (19-9-W-Mo). The last 250 hr of the Houdry test showed that blades of the latter material suffered only very slight erosion when operating at approximately 750 F, but there is no way of predicting what effect, if any, will result from the use of higher air temperature.

If the tests planned for the coming summer turn out well, the power plant will be installed in a two-unit locomotive chassis. Extensive tests will then be run to determine the suitability of this new form of motive power under actual railway service.

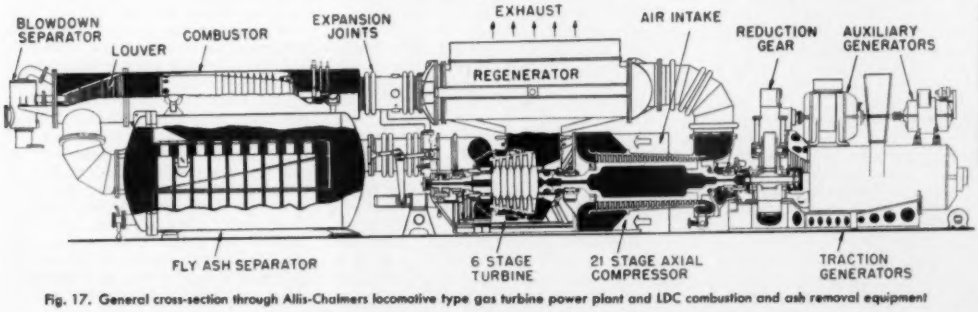


Fig. 17. General cross-section through Allis-Chalmers locomotive type gas turbine power plant and LDC combustion and ash removal equipment

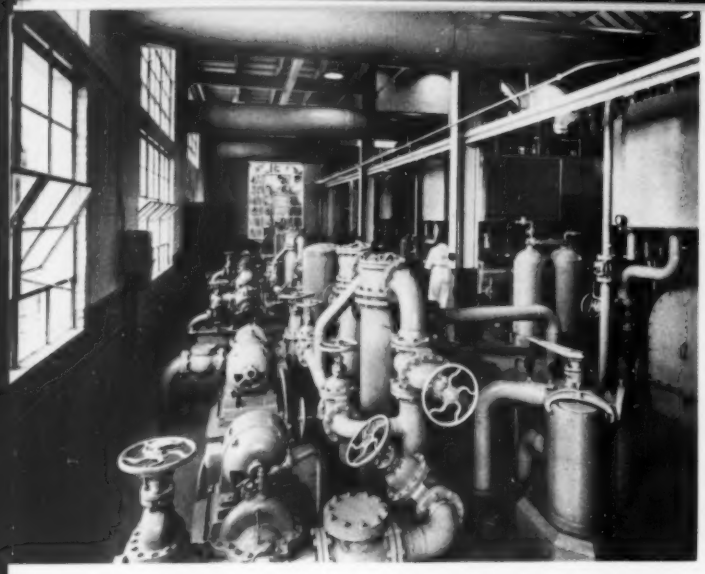


Fig. 1. Auxiliary equipment for each engine includes a Honan-Crane lube oil purifier, a Ross oil cooler, a Nordberg lube strainer, a Blackmer auxiliary lube pump, a Ross heat exchanger and Peerless cooling water pumps

Fuel Costs At Houma

Three 2000-hp Nordberg gas-burning Diesel engines cut costs in half during the first year of operation at the municipal power plant of Houma, Louisiana. Gas consumption was 10.8 cu ft per kilowatt hour and the pilot oil was down to 4.3 per cent. The plant serves an expanding city of 11,000 population and a wider area of 18,000 and also an REA cooperative.

THREE 2000-hp gas-burning Diesel engines in the Houma, Louisiana, municipal power plant generated electric power in the fiscal year ended Sept. 30, 1950, for a total fuel cost of 1.61 mills per kilowatt-hour. This was achieved with a fuel oil price of 9.16 cents a gallon and a gas rate of 12 cents per mcf. It was possible because the efficient prime movers turned out a kilowatt-hour on 10.8 cu ft of gas and a meager 0.0034 gal of pilot oil. The pilot oil was down actually to 4.3 per cent.

Most municipal power systems expand gradually to meet the growing demand and, until 1945, Houma followed this conventional pattern. Initially, a steam plant pioneered the system and the city turned to Diesels in 1922 with the installation of two 300-hp McIntosh & Seymour air-injection engines. A 340-hp unit of the same make was added in 1926. Ten years later, the building was extended to accommodate a 1050-hp Fairbanks-Morse Diesel, and in 1938, a 1080-hp Alco-Sulzer unit was added. In 1942, the city bought another engine, but the War Production Board found higher priority need for the unit and it was never delivered.

The city pulled through the next few years with existing equipment but the growing demand necessitated an additional source of power. The only possible source was the private power company and Houma contracted to purchase power to supplement its own production. From Sept. 1, 1945, to June 30, 1949, the city bought 19,167,453 kwh for a total of $160,145.89, an average of 8.32 mills per kwh. It should be noted that this cost would have been higher except for a credit of $46,353.42 which the utility allowed the city because it had its own plant.

It was clear to Houma's progressive administrators that the city could generate power for considerably less than the utility charges and they decided to erect a plant addition capable of carrying not only that portion of the load supplied with purchased power but the entire system's demand. Thus, Houma could have the most modern and efficient generating equipment for power production at low cost, with the old Diesels serving as standbys. Implementing this decision, Houma constructed a wing on its light and water plant and installed three Nordberg gas-burning Diesel engines, each of five cylinders, 21½ in. bore and 29 in. stroke, rated at 2000 hp at 225 rpm. These two-cycle engines burn natural gas with a small quantity of pilot fuel to initiate combustion. They can also operate as oil-burning Diesels.

The three units went into full operation in June, 1949, and Houma stopped buying power. The official city financial report for the year ending Sept. 30, 1950, shows the economic effects of generating power in the new plant. Total generating costs were $67,376.84 for 19,009,600 kwh compared with $107,715.24 for the 15,671,255 kwh generated and purchased the previous year. With the gas engines in operation, the cost of labor, fuel, lube, maintenance, supplies, repair parts and small tools was 3.54 mills per kwh. Since the comparable cost of generated and purchased power the year before was 6.87 mills, the city saved 3.33 mills per kwh or $63,301.97 at the 1950 volume of production.

Comparison with the cost of purchased power alone is even more striking. If all the 19,167,453 kwh purchased by the city at 8.32 mills had been generated at the 1950 cost of 3.54 mills, the saving would have been $91,620.42.

The basis for the low generating cost inevitably is fuel economy. Total fuel cost for the entire plant was 1.75 mills per kwh. For the gas-burning engines, fuel cost just 1.61 mills.

In the 1950 fiscal year, the three new Nordberg gas-burning engines generated 18,783,000 kwh, 98.8 per cent of the total. The engines consumed 203,099,000 cu ft of natural gas, an average of 10.8 cu ft per kwh. Pilot oil consumption was particu-

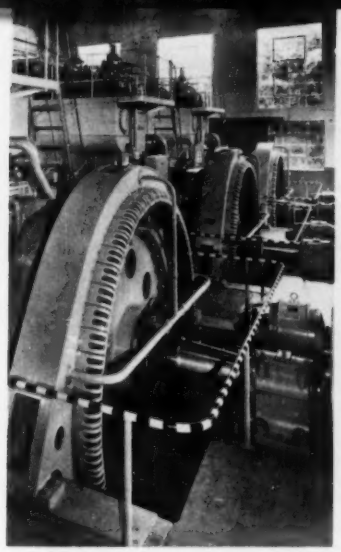


Fig. 2. View of the three Nordberg two-cycle, five-cylinder, 21½ by 29-in. gas-burning Diesel engines

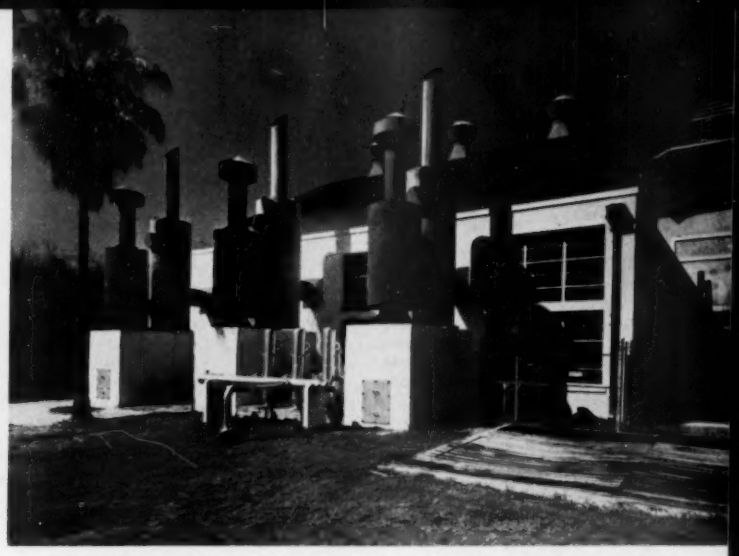


Fig. 3. Exterior view of the Houma plant showing the Maxim exhaust silencers, gas inlet pipe, and Nordstrom gas valves

1.61 Mills per KWH

larly low, a total of 65,213 gal or 0.0034 gal per kwh. Expressed in terms of heating value, gas provided 10,433 Btu per kwh and fuel oil 468 Btu for a total of 10,901 Btu per kwh. The pilot oil's contribution was a lean 4.3 per cent. Lubricating oil consumption also was low, a total of 5307 gal for the year. With the three engines running a combined total of 19,464 hours, this represented a lubricating oil consumption of one gallon per 7335 hp hr. Table I gives detailed monthly operating figures for the year.

A detergent oil is used for upper cylinder lubrication and a straight mineral oil in the crankcase. Lube is pumped continuously from the sump through a fuller's earth purifier and back to the sump. The lube system for each engine includes a shell-and-tube oil cooler and a motor-driven auxiliary pump used in starting and stopping the engine and as a standby for the main lube circulating pump.

Houma is in the midst of oil and gas country and the natural gas is purchased from a local company. The gas is not processed in a dehydration plant and retains many of the light ends. LHV is 966 Btu per cu ft. Reaching the plant at 30 psi, the gas passes through a scrubber, meter and regulator and goes to the engine compressors. There are thermometers in the gas lines to permit a temperature correction in calculating the volume of gas consumed. The engine-driven compressors raise gas pressure to 1150 lb before injection into the cylinders. A motor-driven auxiliary gas compressor can be used if an engine-driven compressor fails. The regular fuel injection pumps serve as gas valve actuators when the engine runs on gas. A separate set of accurate, small-volume injection pump handles the pilot oil. The engines can be operated as full Diesels but the possibility is remote in this gas-abundant location.

A pair of motor-driven centrifugal pumps for each engine circulate the cooling water. One pump sends soft water through the engine jackets and through a heat exchanger. The other pumps raw water from the nearby bayou through the exchanger and then to waste. There are headers on both the soft and raw circuits to permit use of any pump on any engine. Makeup for the jacket supply is treated in a softener. A large overhead water tank serves as protection against damage through pump failure.

A gage board near each engine holds pressure gages, an alarm panel and an exhaust pyrometer. The new 15-panel switchboard is metal-clad and has electrically-operated switchgear. Circuit breakers can be rolled right out of the board for servicing. Instrumentation is particularly complete.

Houma spared no expense in equipping the new power plant for this was regarded as an investment in efficiency. This municipal power system has a long record of profitable operation but the new plant is paying unprecedented dividends. In the last

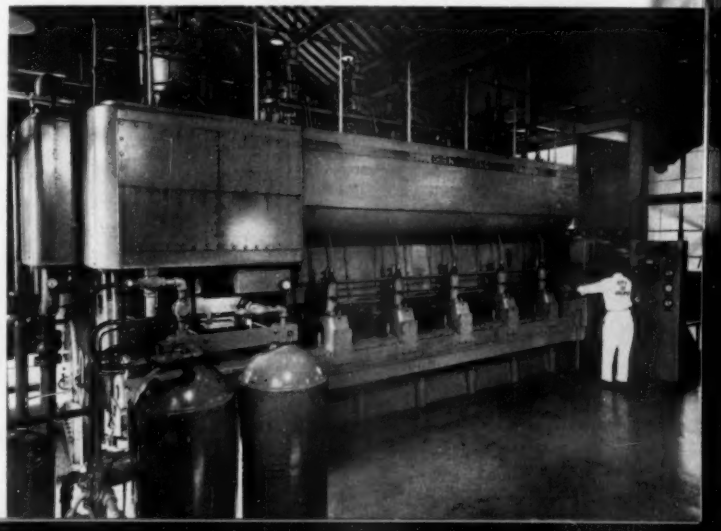


Fig. 4. Operating side view of one of three 2000-hp Nordberg engines showing the gage board at the right of the operator

TABLE I

	KWH Generated				Pilot Oil		B. t. u. per KWH					
	Total Plant	Gas Units	Gas Consumed MCF*	Gas cu ft per KWH	Total Gal.	per KWH	Gas	Oil	Total	% Pilot Oil	Cyl. Lube Oil	Engine Hours
1949												
Oct.	1,601,000	1,574,000	17,333	11.0	5,571	.0030	10,626	412	11,038	3.7	366	1740
Nov.	1,218,000	1,216,000	12,928	10.6	4,097	.0033	10,240	454	10,694	4.2	279	1300
Dec.	1,316,400	1,305,000	13,846	10.6	4,521	.0034	10,240	468	10,708	4.3	297	1369
1950												
Jan.	1,362,400	1,122,000	11,874	10.5	4,398	.0039	10,143	536	10,679	5.0	405	1284
Feb.	1,232,200	1,353,000	14,191	10.4	4,718	.0034	10,046	468	10,514	4.4	408	1402
Mar.	1,345,000	1,345,000	14,389	10.6	4,812	.0035	10,240	481	10,721	4.5	444	1420
Apr.	1,358,600	1,357,000	15,026	11.0	4,973	.0036	10,626	495	11,121	4.4	470	1467
May	1,791,200	1,781,000	18,843	10.5	6,378	.0035	10,143	481	10,624	4.5	564	1887
June	1,816,400	1,890,000	20,728	10.9	6,357	.0033	10,529	454	10,983	4.1	540	1885
July	1,875,200	1,858,000	19,998 *	10.7	6,441	.0034	10,336	468	10,804	4.3	547	1862
Aug.	2,135,000	2,065,000	22,688	10.9	6,637	.0032	10,529	440	10,969	4.0	547	1966
Sept.	1,958,200	1,917,000	21,255	11.0	6,310	.0032	10,626	440	11,066	3.9	440	1882
Total	19,009,600	18,783,000	203,099	10.8	65,213	.0034	10,433	468	10,901	4.3	5,307	19,464

* Figures for 1950 are corrected for temperature.

Table II. Comparative Statement of Operating Expenses

For fiscal years ending September 30, 1947, 1948, 1949, 1950

	Sept. 30, '47	Sept. 30, '48	Sept. 30, '49	Sept. 30, '50
GENERATION				
Salaries and wages	15,854.92	16,951.41	18,695.83	22,876.74
Engine fuel	50,552.88	58,537.42	35,067.50	33,298.05
Lubricants	7,143.74	6,554.72	4,871.94	5,226.25
Maintenance equipment	18,888.58	4,148.92	1,675.48	3,098.49
Structures & improvements	273.95	450.57	488.37	1,152.26
Purchased electricity	30,551.00	59,506.08	45,145.94	
Supplies	1,509.48	726.27	643.78	646.34
Small tools	50.81	98.09	446.98	188.42
Calibration & chart reading			210.00	422.75
Repair parts	472.02	52.32	138.88	20.31
Compensation insurance	206.36			
Miscellaneous		9.17	330.54	447.23
Total Generation Expense	125,503.74	147,034.97	107,715.24	67,376.84
TRANSMISSION AND DISTRIBUTION				
Salaries & wages	24,175.50	10,498.02	5,528.37	5,668.30
Maintenance & repairs, lines, wire, hardware	30,781.87	7,763.94	4,588.74	10,523.35
Truck repairs	530.85	676.37	2,162.80	537.22
Gasoline & oil	831.41	622.90	820.01	793.66
Small tools	419.90	76.84	82.72	49.02
Supplies	124.64	183.16	100.41	54.55
Compensation insurance	336.50			
Miscellaneous	129.95	392.45	296.12	361.54
Total Transmission & Dist.	57,330.62	20,213.68	13,579.17	17,987.64
TOTALS	182,834.36	167,248.65	121,294.41	85,364.48

fiscal year, after payment of all costs of production, distribution, administration, insurance, and depreciation, the electric department had a net profit of $253,308.15. This is true in spite of the fact that electric rates to consumers are among the lowest in the state.

Power plant profits are important to Houma, financing both current government and long-range improvement. In the past five years the city has spent $875,000 for the new plant, $150,000 to rewire 90 per cent of the distribution system, $400,000 for a sewage gathering system, and $225,000 for a sewage disposal plant and a fire defense system. All this has been achieved without special tax levies. In the last four fiscal years, expenditures of the city general revenue fund exceeded income by $324,792.98 with the electric department making up the difference. With a profitable power plant paying the bills, taxes are low and most residents pay no local taxes at all. As an extra dividend, the plant provides the city free services valued at $46,000 a year.

Houma is a thriving, expanding city of 11,000 population with its prosperity firmly based on oil, fish, fur and sugar cane. This is the shrimp center of Louisiana. The plant serves a wider area with 18,000 population and also an REA cooperative.

Fig. 5. A new wing (at right) was added to the Houma plant to accommodate the three new 2000-hp engines. The plant addition was designed by City Engineer J. C. Pittman

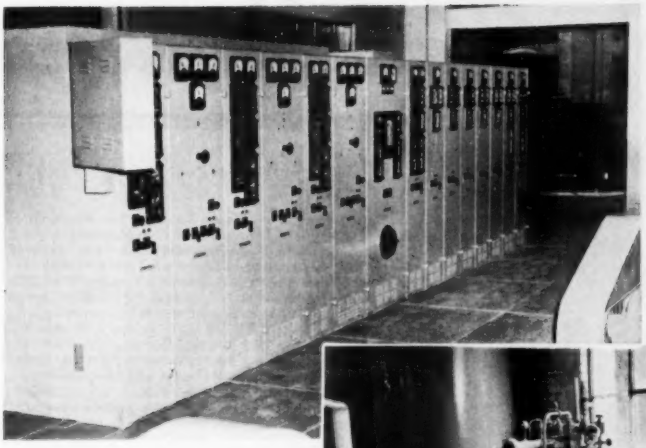


Fig. 6 (Left). The 15-panel metal-clad General Electric switchboard has electrically-operated switchgear. Circuit breakers can be rolled out of the board for servicing

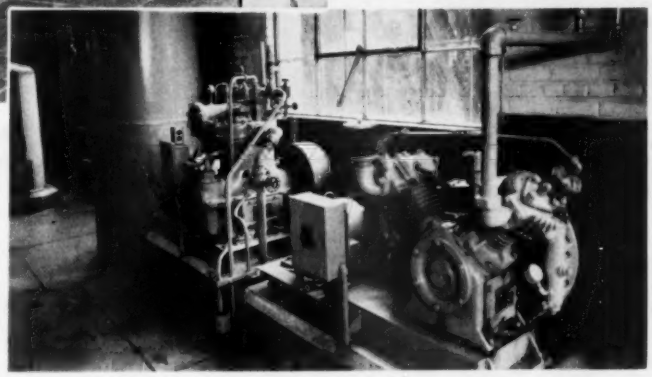


Fig. 7 (Below). These are the two motor-driven Gardner-Denver compressors, a 250-lb air compressor at the right and a 1200 lb auxiliary gas compressor at the left

An important factor in the development of Houma's power prosperity and the construction of its efficient new plant has been the city's administrative team with Mayor Leon Gary and Aldermen Gibson J. Autin, Sr., William J. Cenac, Jr., Paul V. Haydel, Lucas Marcello and Christian L. Olivier, Jr. Important in both the planning and successful operation of the plant is J. C. Pittman, City Engineer and Superintendent of the Light & Water Department.

Table III. Comparative Statement of Income and Expenses

For fiscal years ending Sept. 30, 1947, 1948, 1949, 1950

	Sept. 30, '47	Sept. 30, '48	Sept. 30, '49	Sept. 30, '50
INCOME				
Sales of electricity	295,404.49	381,714.17	393,876.17	431,050.63
Services	1,025.16	2,227.95		
Penalties	2,122.88	2,565.59	2,414.41	3,045.30
Installation & transfer fees	1,367.00	1,018.00	1,164.00	1,220.50
Sales of scrap				2,498.82
Miscellaneous	1,437.32	714.68	920.58	81.64
TOTAL INCOME	301,356.85	388,240.39	398,375.16	437,896.89
EXPENSES				
Operating Expenses				
Generation	125,503.74	147,034.97	107,715.24	67,376.84
Transmission & Dist.	57,330.62	20,213.68	13,579.17	17,987.64
Depreciation	15,865.93	15,908.30	28,299.88	47,276.93
TOTAL OPERATING EXPENSES	198,700.29	183,156.95	149,594.29	132,641.41
General & Administrative Expenses				
Salaries	5,679.89	5,578.21	6,623.30	7,614.81
Office supplies & expenses	265.69	512.86	559.75	427.61
Telephone & telegraph	144.35	280.68	449.16	487.46
Insurance, general	395.69	531.41	1,863.75	2,591.57
Insurance, engine breakdown			1,079.44	2,747.05
Compensation insurance	13.63	1,355.93	1,022.89	1,514.56
Postal cards	280.11	345.00	384.84	280.18
Automobile expenses			390.80	1,141.08
Freight & use tax on materials				993.29
Miscellaneous	248.80	303.50	14.55	54.72
TOTAL GEN. & ADMIN. EXPENSES	7,028.16	8,907.59	12,388.48	17,852.33
Discount allowed customers less discounts earned	25,222.64	31,424.00	32,051.42	34,095.00
TOTAL EXPENSES	230,951.09	223,488.54	194,034.19	184,588.74
Excess of Income over Expenses	70,405.76	164,751.85	204,340.97	253,308.15

Equipment Listing for three New Engines

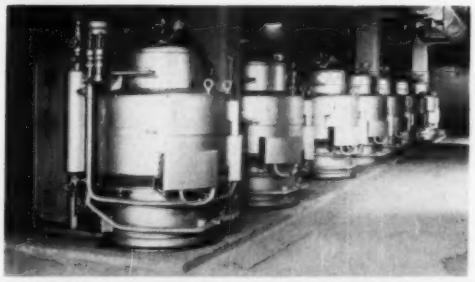
Engines	Three 2000 hp, 21½ x 29, 225 rpm five cylinder gas-burning Diesel engines. Nordberg Mfg. Co.
Alternators	Three 1763 kva, 1410 kw, 2400 volt, 3 phase, 60-cycle alternator with V-belted exciter. Elliott Co.
Gas	Sugar Bowl Gas Co.
Scrubber	Blaw-Knox
Gas valves	Nordstrom
Gas meters	Emco
Actuator pumps	American Bosch Corp.
Fuel oil	Standard Oil Co. of Louisiana
Fuel filter	Wm. W. Nugent & Co., Inc.
Fuel pumps	American Bosch Corporation
Governors	Woodward Governor Co.
Lube oil	Rotella 40 in cylinders Talpa 30 in crankcase. Shell Oil Co.
Lube oil filter	Hanan-Crane Corp.
Lube oil cooler	Ross Heater & Mfg. Co., Inc.
Auxiliary Lube pump	Blackmer
Water pumps	Peerless
Heat exchanger	Ross Heater & Mfg. Co., Inc.
Zeolite softener	Illinois Water Treatment Co.
Compressors	Gardner-Denver Co.
Gage board	Nordberg Mfg. Co.
Pyrometer	Alnor. Illinois Testing Lab., Inc.
Alarms	Viking Instruments Inc.
Gages	Lonergan
Motor-control panels	Westinghouse Electric & Mfg. Co., Inc.
Switchboard	General Electric Co.
Batteries	Exide
Air filters	American Air Filter Co., Inc.
Silencers	Maxim Silencer Co.

Power Engineering

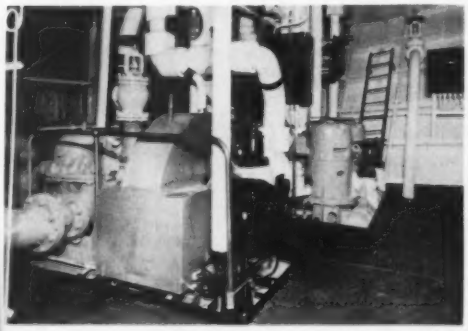
Left—First of the hungry horses go into their stalls at Hungry Horse Dam. Production of hydroelectric power at Hungry Horse Dam on South Fork of Montana's Flathead River moved a step closer this week with start of installation of the first 105,000-hp turbine. Here, one of the 290-ton powerhouse cranes is lowering the first 28-ton section into place in the turbine pit. First two Hungry Horse generators are scheduled to go on the line in October and December 1952. Plant's full rated capacity of 285,000 kw from four generators available by November 1953.

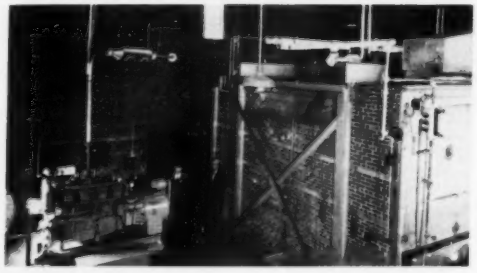
Installation of the four turbines is being handled by the Grafe-Shirley-Lane Co. of Los Angeles, contract covering finish work on the dam and completion of the powerhouse and high-voltage switchyard. (Bureau of Reclamation photo)

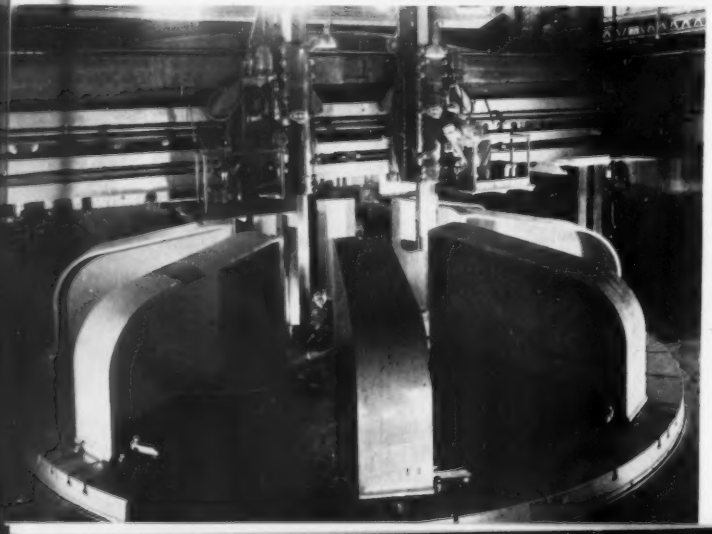
Right—Rear view of seven Vapor Clarkson oil-fired, automatically-controlled, 4500-lb-per-hr each 250-psi, steam generating units installed in basement of new Union Pacific laundry at Ogden, Utah. Units originally designed for railway train heating; this is one of first stationary applications



Below—Installation of General Electric DP mechanical drive turbines, on each of five new tankers, marks first marine use of these standardized turbines. Eight are installed on each ship for various feed pump, cargo pump and fire pump drives. They operate at 550 psig, 550 F and at various speeds





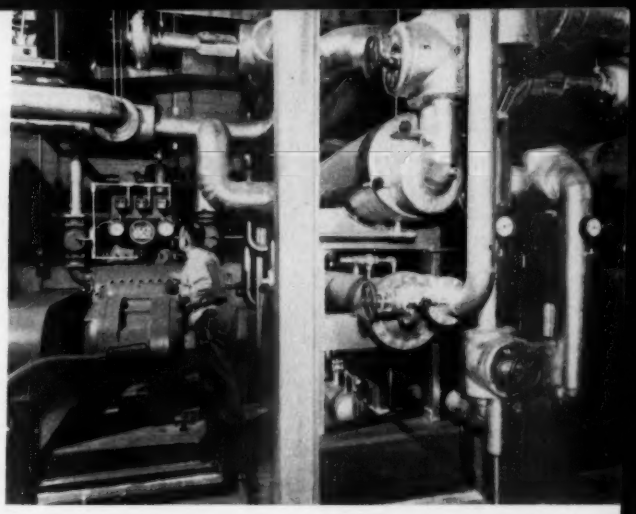


Above—Last November, as a hurricane swept over Long Island, N. Y., at Louden Knickerbocker Hall, a private institution for mental treatment at Amityville, the institution was kept running smoothly by the Caterpillar standby Diesel-electric set, when the storm knocked some power lines out of service. The boilers are 100-hp oil-fired units

Left—Radial arms of upper bearing and thrust bearing support for an 82,500-kva, 100%-pf, 180-rpm, suspended-type vertical synchronous generator for Hoover Dam are here being machined on a 40-ft boring mill in Allis-Chalmers shops.

The generator is one of two to be driven by 115,000-hp, 480-ft head hydraulic turbines. The two turbines will be duplicates of seven previous units built by Allis-Chalmers for this same installation, except that the spiral casing sections are of welded plate steel construction instead of cast steel as in the original units

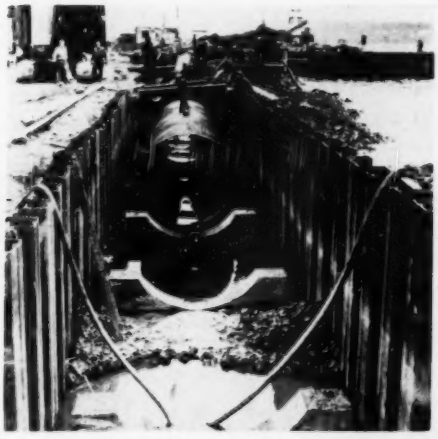
NEWS REEL



Right—This is a Texas-size heat pump—it says here—installed in 1950 to serve the large new office building and service center of Gulf States Utilities Co. at Beaumont, Texas. It includes two systems, each consisting of a Freon-12 compressor with driving motor, condenser and water chiller along with coil-type conditioners, auxiliaries and controls. Well water is used for both summer cooling cycle and winter heating cycle. Change-over from summer to winter operating cycles and back again is done automatically. The system was built by York Corp.

Water leaving the cooler, in summer operation, is maintained at an average temperature of 43 F. For winter heating, a water temperature of 107 F from the condenser is maintained.

Even though gas and fuel oil are very reasonable in price in the Beaumont area, Gulf States Utilities selected the reverse-cycle heating along with the cooling equipment, the latter considered a necessity in that part of the country.



Below—R. M. Casper (right), manager of Allis-Chalmers electrical department, and J. L. Singleton, vice president and director of sales of the company's general machinery division, study a one-inch-to-one-foot scale model of a typical SCS single circuit unit substation designed for use as a visual selling aid.

Equipment in the single-circuit unit substation is functionally grouped and Mr. Casper points to one of a number of advantages—a single assembly unit which houses all switchgear components.

The SCS unit substation is used for providing 750 to 5000 kva at 2400 v to 13,200 v to utility and industrial loads. The model, built to show the accessibility and flexibility of this particular unit substation, is made of wood, metal and plastic

Above—One of the largest wrought-iron pipes in existence was installed recently near Poughkeepsie, N. Y., at the Danskammer Point Steam Station of Central Hudson Gas and Electric Corp., designed by the engineering firm of Burns & Roe. The pipe was fabricated on the site from ¾-in plate by workers of Treadwell Construction Co., Midland, Pa. It is 300 ft long, 84 in. in diameter. Two longitudinally welded seams were used. The pipe carries circulating water discharge from the station's condenser into the Hudson River

Right—One of two outdoor GE steam turbine generators installed at Morgan Creek Steam-Electric Station of Texas Electric Service Co. Each unit has a rated generator capacity of 20,000 kva, 0.8 pf at 0.5 psi hydrogen pressure. They generate at 13,200-v. Turbines are 3600-rpm single-flow, single casing, condensing, 17-stage, with extraction at 6th, 12th and 15th stages. Removable housings over turbine governor and exciter. Each unit is supplied with steam at 850 psi, 900 F by a Foster Wheeler 220,000-lb-per-hr outdoor steam generating unit (*News Reel*, May 1951, page 73). Plant designed by Ebasco Services, Inc. (Foster Wheeler photo)

Instruments and Controls for Small A-C Generators—How to Use Them Right

By DENARD L. GUSLER

WHEN CONSIDERING the installation of a small generator, one of the first problems is to get the necessary switchgear and instruments for its operation and protection. The company from which the equipment is purchased will usually recommend the instruments needed; but it is the engineer who generally has to make the final decision. To install too many instruments is useless and expensive. To install too few instruments is hazardous and false economy.

For the purposes of this article we will consider a 1000-kw, 3-phase, alternating-current generator, rated at 4160 v, and 80 per cent power factor. The generator will be connected star with a grounded neutral. It will be expected to operate with other generators which have similar electrical characteristics. Adequate protection against overload and unbalanced currents will be provided. Typical instruments required are shown in the accompanying table.

While a thorough understanding of the purpose and operating principle of instruments is important, it is also necessary for the engineer to know how the instruments are applied in the generator control circuits. This knowledge is not easily acquired, for several reasons. One is the compactness of modern switchgear and the necessity for installing a maximum of instruments in a minimum of space. Many wires are run together in bundles, making them almost impossible to trace out. In high-voltage switchgear, most of the instruments and wiring are enclosed, so that it is difficult for anyone besides the person making the installation to study and learn the circuits.

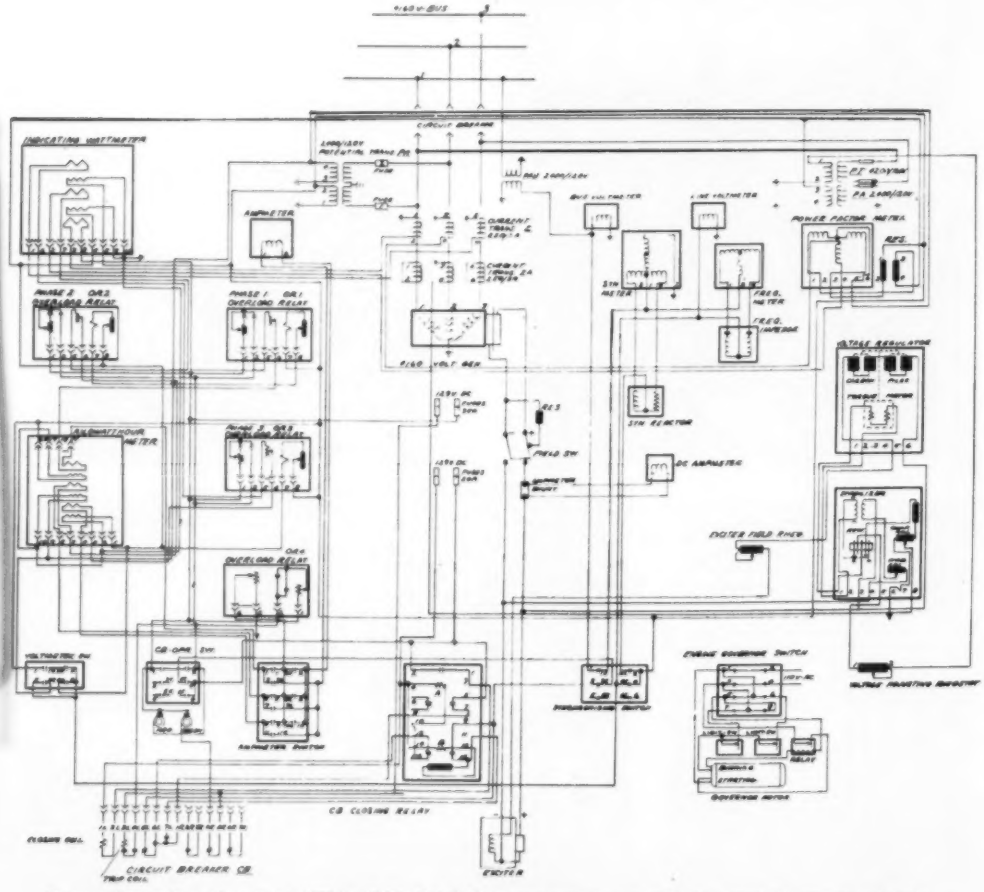


Diagram of a switchboard for a typical 1000-kw, 4160-v, 0.8 pf, 3-phase a-c generator, showing physical layout of instruments and circuits

The diagrams that come with the switchboard are usually too intricate to be readily understandable or, as in the case of the single-line schematic, they are too simple to do much good. The average switchboard operator will perform the daily operations without making any effort to learn all that actually takes place when a rheostat is turned or a lever is moved. Frequently an operator will go an entire year without performing a single function other than occasional adjustment of the voltage and generator load.

In the diagram a set of instruments for one generator is laid out in general as they are physically located, with lines representing circuits drawn directly to the coils or contacts that they are to serve. In considering how these instruments are applied in the various circuits, it must be understood that

A GENERATOR IS ALWAYS IN ONE OF THE FOLLOWING CONDITIONS:

1. **OFF THE LINE**
2. **IN THE PROCESS OF BEING PUT ON THE LINE**
3. **ON THE LINE**
4. **IN THE PROCESS OF BEING TAKEN OFF THE LINE**

Step by step we will consider each of these conditions.

1. Off the Line

When the generator is at rest all instruments are on zero and inactive. About the only protection needed is a means of preventing a careless operator from closing the main breaker, thus throwing a direct short circuit on the system. With reference to the diagram it will be seen that the closing coil of the circuit breaker cannot be operated unless the synchronizing switch is turned on. With the synchronizing switch off, contacts 3–3c are open thus preventing accidental operation of the main breaker. A later discussion will show just how this is possible.

The green indicating light is burning when the circuit breaker is open. The circuit is from 129 v d-c positive fuse 35 amp through 4R of the circuit breaker and contact through 5R to 129 v d-c negative fuse 35 amp. This circuit shows possible points of failure in case the green light is not burning. The most likely cause of failure is a burned out bulb.

2. In the Process of Being Put on the Line

Step A — Adjust voltage of the generator.

Referring to the diagram, 120-v a-c from potential transformer PT 4200/120v between phases 1 and 3 flows through the voltage-adjusting rheostat to a copper-oxide rectifier in the voltage-regulator control cabinet. Increased resistance of the rheostat will lower the value of the d-c voltage, which operates the torque motor. The carbon piles are then tilted forward, shorting out the resistance of the carbon piles which are in series with the exciter field rheostat and the exciter field. Lowering of the carbon pile resistance causes the exciter voltage, and thus the generator voltage, to rise in value. Decreasing the resistance of the voltage adjusting rheostat will lower the value of the generator voltage.

Step B — Check generator phase voltage.

The voltmeter switch is connected as follows: No. 1 contact to potential transformer PA 2400/120v on phase 1. No. 3c to potential transformer on phase 2. No. 4c to potential transformer on phase 3. No. 2–3–4 to the line voltmeter. To check phase 1 voltage, contact 1–2 is closed. To check phase 2 voltage, contact 3–3c is closed. To check phase 3 voltage, contact 4–4c is closed.

Step C — Set engine speed by frequency meter.

The activating voltage for the frequency meter comes from the generator phase that the voltmeter switch is turned to, or from phase 1 through 4–4c of the synchronizing switch when the latter is on and the voltmeter switch off.

The engine governor switch has two positions; RAISE and LOWER. In the raise position contacts 1–2, 3–4, 1–5, 3–7 are closed, thus operating the governor motor in a direction that will compress the governor spring. In the lower position, contacts 1–2, 3–4, 1–6, 3–8 make contact, and the governor motor rotation is reversed, thus releasing the governor spring and unloading the engine or, if it isn't synchronized, slowing it down.

Step D — Turn on synchronizing switch.

All contacts close.

Closed contacts 1–1c, 2–2c, 4–4c energize the synchroscope and frequency meter on the incoming machine. Closed contact 3–3c allows main breaker to be operated.

Switchboard Instruments — How They Work and What They Are Used For

A-C VOLTMETER

Purpose: — To indicate the phase-to-ground voltage. Connected to read on any selected phase.

Operating Principle: — A measuring current from a potential transformer flows through a fixed field coil. A soft iron core inside the coil is attached to a shaft, which carries the indicating pointer. The iron core is deflected, in opposition to a spring, in proportion to the measuring current. A voltmeter switch selects the phase to be measured.

A-C AMMETER

Purpose: — To indicate the phase current. Connected to read on any selected phase.

Operating Principle: — Same as for the voltmeter with the exception that the measuring current comes from a current transformer. An ammeter switch selects the phase to be measured

INDICATING WATTMETER

Purpose: — To indicate the load that the generator is carrying in kilowatts. This is not kilowatts per phase but the entire generator load.

Operating Principle: — This meter contains two potential coils revolving inside three current coils, with a resultant torque governed by the value of the two components. The shaft on which the potential coils are mounted carries the indicating pointer and vanes, which operate between fixed damping magnets.

INTEGRATING KILOWATT-HOUR METER

Purpose: — To record on an integrator the kilowatt hour output of the generator.

Operating Principle: — Same as the indicating watthour meter, with the exception that the operating shaft revolves and operates an integrator. This same mechanism can be used to record continuously on a strip of paper.

POWER FACTOR METER

Purpose: — To indicate the relation between the true power and the apparent power of the generator.

Operating Principle: — A common type is called the crossed-coil meter. There is a fixed coil through which the line current flows and two moving coils which are mounted on a common shaft at an angle with respect to each other. The moving coils are connected across the line through a resistor and a reactor in such a manner that there is a suitable phase difference between the currents in the two coils, and so that the torques of the two coils oppose each other. Since this ratio varies as the phase angle between the current and the voltage, the instrument can be calibrated in terms of any function of the phase angle. It is normally calibrated in terms of the cosine of the phase angle, which is the power factor of the circuit.

FREQUENCY METER

Purpose: — To make it possible for the generator to be operated at the correct speed, to provide accurate control of electric clocks, and to indicate the speed of the generator before cutting in the synchroscope.

Operating Principle: — A common type is the resonant-circuit meter. The meter has two fixed coils inside of which there is an armature coil on a shaft, which operates the pointer. The fixed coils are alike and connected so that their fluxes oppose each other. Each coil is connected in series with an inductance-capacitance combination whose constants are such that series resonance is produced — below the operating range for one field circuit, and above the operating range for the other.

These series-resonant circuits provide deflecting torque having a definite relationship to the frequency of the applied voltage, without regard to its amplitude. For a 60-cycle system, the field circuits are commonly resonated at approximately 45 cycles and 75 cycles. The armature coil is connected through lead-in spirals having practically no torque, so that it carries the total current of both field circuits.

D-C AMMETER

Purpose: — To indicate the current from the exciter to the field of the generator.

Operating Principle: — A current coil is mounted on a shaft between the poles of a permanent magnet. The shaft operates a pointer. Current passing through the coil produces a magnetic field which interacts with that produced by the permanent magnet and thus supplies deflecting torque.

SYNCHROSCOPE This instrument is extremely important.

Purpose: — To indicate whether or not two generators, about to be synchronized, have the same phase sequence.

Operating Principle: — A common type of synchroscope is the crossed-coil instrument, which is similar in principle to the power factor meter previously described. The essential difference is that the moving element must be free to rotate. This rotation is made possible by using slip rings to carry the current to the moving coils instead of lead-in spirals.

OVERCURRENT RELAY

Purpose: — To trip out the generator in case of excessive current.

Operating Principle: — These instruments are generally of the induction-disk construction type. The disk is actuated by a current-operating coil on a laminated magnet. The disk shaft carries the moving contact which completes the trip circuit when it touches the stationary contact. The disk shaft is restrained by a spiral spring to give the proper contact-closing current and its motion is retarded by permanent magnets acting on the disk to give the correct time delay.

A seal-in element mounted in the case has its coil in series and its contacts in parallel with the main contacts such that when the main contacts close the seal-in element picks up, and seals in. When it picks up it raises a target into view, then latches up and remains exposed until released by the operator.

Step E — At proper interval, as indicated by the synchroscope, close the main circuit breaker by turning the circuit breaker operating switch to the close position.

Contacts 4–4c close, thus energizing coil A in the circuit-breaker closing relay. Energized coil A closes contacts 2–3 and 5–7. Closed contacts 2–3 energize the closing coil of the main circuit breaker, thus opening all normally-closed contacts and closing all normally-open contacts. Contact 7L on main breaker closes, causing coil B to energize through contact 5–7. Energized coil B operates contact 9–15 and opens 16–12. Open contacts 16–12 de-energize coil A, which opens contacts 2–3. Closing coil is de-energized on the main circuit breaker. Coil B and contacts seal-in, to make the system "pump free" by closing contacts 15–9. Coil B is de-energized when the synchronizing switch is turned off, thus opening contacts 3–3c. The red light is now burning through closed contacts 3L–4L and the trip coil of the main circuit breaker.

3. On the Line

Step A — Check phase voltage and current from time to time.

To check generator phase voltage, proceed as in step B of condition 2.

To check phase 1 current of the generator the ammeter switch is turned to position 1, closing contacts 2–3–5–9. The circuit is from tap 2 of current transformers Z to wattmeter tap 3 through current coil to tap 6. Tap 6 to tap 18 of watthour meter through current coil to tap 17, thence to contact 1 on the ammeter switch. Current flows through 3–3c to the ammeter thence through 2–2c to tap 6 on overload relay 4. From tap 5 the circuit is to ground. The ammeter switch puts the ammeter in series with coils in the wattmeter, the kilowatt-hour meter, a phase overload relay and an unbalanced circulating current overload relay to ground.

To check phase 2 current of generator, the circuit is as above, with the exception that closed contacts are 1–6–7–9.

For phase 3, the closed contacts are 1–5–10–11.

Step B — Main circuit breaker opens due to overload.

Contacts between taps 1–2 of all overload relays are in parallel with contacts 1–2 of the circuit breaker operating switch. Closing of any of these contacts will energize the trip coil of the main breaker, thus opening the circuit.

Overload relays 1–2–3 shown are time-delay type with voltage restraint, which accounts for the potential element in each relay.

It will be noted that the current transformer ratio is 250/5 amp or 50/1. The current coil of each overload relay has a movable tap so that the relay can be set to trip on the desired current. On tap 4, the tripping current would be 200 amp. On tap 5, the tripping current would be 250 amp.

Step C — Adjust the power factor.

When the generator is on the line, the voltage is adjusted by means of the voltage adjusting rheostat as in Step A of process 2. The voltage will remain the same but the power factor will change as the generator excitation is changed. The power factor is generally determined by the reactive current of the system that the generator supplies. Once the correct voltage and power factor are determined, all the operator has to do is adjust the rheostat. Occasionally it might be necessary to adjust the exciter field rheostat, but only in rare instances when the voltage regulator is inoperative.

When two generators are operated in parallel, it is easily possible to unbalance the field excitation so that circulating currents will flow between the generators through the ground connection. When this happens, overload relay 4 will operate to trip out one of the generators. If the relay fails to operate, one of the generators will motorize and run as a synchronous motor. It is very necessary therefore that the proper power factor be maintained at all times.

Step D — Automatic control of the generator voltage.

Any change of the generator voltage will change the primary and thus the secondary voltage of the potential transformer PT 4200/120v. A change in the secondary voltage is the same in effect as a change in the voltage-adjusting rheostat. Once the voltage-adjusting rheostat is set the generator voltage is controlled by the secondary voltage of transformer PT.

4. In the Process of Being Taken Off The Line

Step A — Turn the governor switch to the lower position and, as the generator unloads, adjust the power factor with the voltage-adjusting rheostat.

Step B — At the instant the generator unloads, turn the circuit breaker operating switch to the open position.

This closes contacts 1–2, energizing the trip coil of the main breaker. This action opens contacts 3L and 4L in the trip circuit that cause the red light to burn and closes contact 4R–5R causing the green light to come on.

Voltages Handled on Generator Switchboard

The generator switchboard under consideration may be resolved into several different voltages for various purposes. They are as follows:

1: — 4160 v — Phase Voltage

With the generator star-connected, see diagram, the voltage of the main bus is measured directly between phases. This is the main power supplied by the generator to the equipment that it operates.

2: — 2400 v — Phase-to-Ground Voltage

This is the voltage of any phase to ground. Multiplied by the square root of 3, it equals the phase voltage. Its application in the switchboard is adequately shown in diagram. In addition, it is widely used for lighting transformers and street-lighting circuits.

3: — 120-v A-C — All Potential Transformer secondaries

Potential transformers PA are connected from each phase to ground. They are used for the voltage elements in the indicating wattmeter, kilowatthour meter, overload relays, voltmeter, frequency meter, and the power-factor meter. Potential transformer PAB is connected to the bus for the operation of the synchroscope. Potential transformer PT operates the voltage regulator as previously described.

4: — 1 to 5 amp — All Current Transformers

Current transformers Z operate current coils as indicated in the circuits in Fig. 1. Current transformer ZA is for the compensating adjustment of the voltage regulator.

5: — 120 v D-C — Control Voltage Supplied by Batteries

This voltage is for the sole purpose of operating the coils in the circuit breaker closing relay, the closing and trip coils in the main breaker, and the indicating lights. It will be noted that there are two circuits: the trip circuit, which is fused for 35 amp and the closing circuit, fused for 20 amp. The trip circuit furnishes the power for the indicating lights. This power is furnished by batteries connected in series and charged continuously by a copper-oxide rectifier. The batteries provide a reliable source of power under all conditions and make the switchboard much safer to operate.

6: — 0–150 v D-C — Exciter Voltage

This voltage will usually have a fairly constant value, the current being determined by the exciter field excitation as regulated by the voltage regulator. This voltage is used to energize the field of the generator. If for any reason the generator field switch is opened while the field is energized, an enormous current is built up. This current discharges through the resistor connected across the field switch as it opens. An ammeter shunt is provided to allow a small voltage drop in proportion to the flow of current through the circuit. An ammeter is connected across this shunt to indicate the flow of current in the d-c circuit to the generator.

7: — 120 v A-C — To the Engine Governor Motor

This power is supplied from a regular lighting circuit in the power house. It should be installed and fused in such a manner that no one can tamper with it.

The operator who follows the above instructions carefully will improve his work and understand what he is doing.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

ATTRACTIVE? AND HOW!

A cobalt-platinum magnet, which in small sizes is described as the world's most powerful magnet, has been developed at the General Electric Research Laboratory. In this picture Miss Dolores O'Hara, laboratory assistant, shows how one of these new magnets, the size of a pencil eraser, at the right, lifts a steel bar 16 times longer and 24 times heavier than that lifted by an Alnico-5 magnet of similar size. Curiously enough, the new platinum-cobalt magnet is less powerful than the Alnico-5 (rated as the most powerful) in large sizes but more powerful in small sizes. The reason for this is simple. Magnets are limited in size by their tendency to demagnetize themselves if opposite poles—the ends of the magnet—are brought too close together by cutting the magnet shorter and shorter. The new magnet has a strong resistance to this tendency, hence it is possible to make them very small without seriously impairing their attractive power. Early work on the new magnetic alloy was done by German scientists in 1935. However, Dr. A. H. Geisler and Dr. D. L. Martin, of the G-E Research Laboratory state that they have greatly improved the magnetic properties of the alloy.

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A Section of Power Engineering Devoted to
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The NAIL—
An Indispensable Fastener

Most of us take nails for granted. They are cheap, so universally available that we rarely stop to pick one up, and used for so many purposes that we never think of their mechanical significance. At the Atlanta meeting of the ASME in April of this year, however, Professor George E. Stern of the Wood Research Laboratory of Virginia Polytechnic Institute presented a paper in which he endeavored to give the neglected nail some well-deserved attention. This article is based on this paper. Because of its length it was necessary to omit much of the technical data regarding nail sizes, holding power, relative effectiveness of types, etc., but most of the general discussion is included

THE SIZES and types of nails in production and use are numerous. Nails are made of low-carbon, high-carbon or stainless steel, of aluminum, copper, brass, bronze, chromium, nickel, and silver alloys. Nails are manufactured pointless or with blunt, medium or long diamond, needle, chisel, duckbill, side or V points. They are made headless or with standard, medium or large; flat, round, oval, cupped, checkered or slotted; cone, countersunk, brad, hook, double or spiral-wire heads. The round-, triangular-, square- or rectangular-shank nails may be smooth, barbed, etched, twisted or spirally, helically or annularly grooved. Grooved-shank nails may be provided with a clearance and/or a pilot. Special-purpose nails may be blued, annealed, tempered; hot or electro galvanized; copper, nickel, tin or cadmium plated; phosphatized or resin coated. Altogether, more than one-thousand sizes and types of nails are made on request of the numerous nail users.

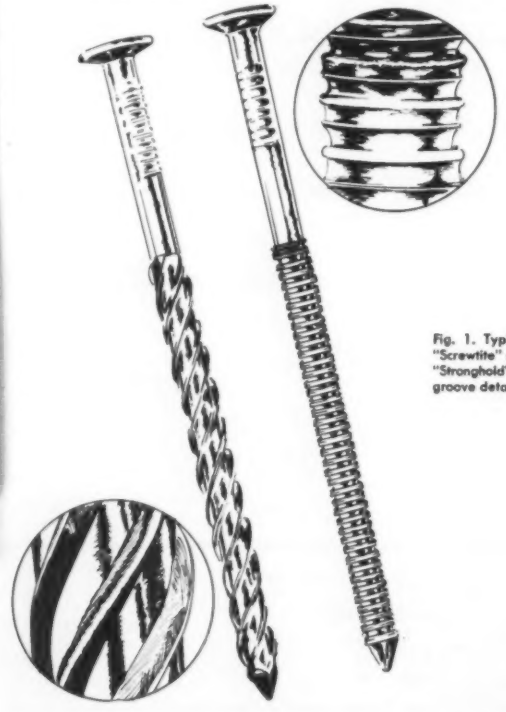


Fig. 1. Typical helically grooved "Screwtite" and annularly grooved "Stronghold" nails. Insets giving groove details are shown enlarged

Nail Size

The nail length ranges from $\frac{1}{8}$ in. for a needle-thin round-headed escutcheon pin to six inches for a heavy structural fastener. The minimum nail diameter is that which is required to drive the nail satisfactorily without buckling the shank. Thus, hardened steel nails may be made of wires of smaller diameters than non-hardened nails, while the somewhat soft aluminum-alloy nails or deeply grooved-shank nails often need to be made of larger wires than common plain-shank steel nails. Consequently, the nail diameter changes with some of the design variables. It is, however, standardized to a considerable extent.

The nail which is employed for most common uses is the Common Nail, a round- and plain-shank low-carbon-steel nail made in penny sizes.

Since a number of standard gages are in concurrent use, the steel-wire gage employed is to be given if nail diameters are specified by wire gage. Despite the prevailing practice of specifying nails by penny size and wire-gage number, it has become more and more acceptable to specify nails by Length in Inches by Diameter in Inches. This procedure is simpler and leads to less uncertainty on the part of nail manufacturer and nail user.

Prevailing practice and experience have led to the recommendation of selecting the nail length in such a

way which allows a shank penetration of one-half of the nail length for dense hardwood and two-third of the nail length for softer woods. In the case of improved nails with increased holding power, as compared with that of plain-shank bright-finished nails, the shank penetration can be decreased provided increased holding power per nail is not required. Thus, improved nails may be either shorter or of smaller wire than plain-shank nails without decreasing the holding power per nail.

The nail size is, of course, also influenced by its end use. Thus, roofing nails which are to fasten relatively thin material must have longer nail shanks than would be computed by the above given rule. Similarly, such nails which are to fasten heavy material usually have to have large shank diameters or have to penetrate deeper into wood because of the necessity to provide sufficient resistance to withdrawal.

According to the "Wood Handbook," the axial withdrawal resistance per inch of penetration of plain-shank nails varies in most cases directly with the nail diameter. According to this reference, the lateral load-carrying capacity of these nails varies with the 1.5th power of their diameter. These general statements make it possible to compute the approximate nail-holding properties, although actual test data may vary considerably from the computed data.

Nail Material

The commonly used nail is made of low-carbon-steel SAE 1008 or 1010. If a stiff nail is required, a large nail diameter may be specified. If this is not advisable, the nail may be made from wire having a slightly higher carbon content. If maximum possible stiffness is specified, nails may be made of high-carbon-steel alloys and subsequently oil-hardened and tempered. Such nails can be made to be driven into hardwoods and concrete and through steel plates. A large percentage of the flooring nails manufactured today are made of high-carbon-steel wire and subsequently heat treated in order to assure satisfactory driving through hard oak or maple flooring. Since high-carbon-steel nails can be and usually are made of slightly smaller diameter than low-carbon-steel nails of same type and length, high-carbon-steel nails are somewhat easier to drive and have correspondingly smaller holding properties than the same-length low-carbon-steel nails.

Monel, a nickel-copper alloy, and stainless steel, a chromium-nickel-steel alloy, are used for nail manufacture when the nail has to resist the action of strong acids and alkalis, such as salt brines, vinegar, fruit and vegetable juices, milk and dairy products, photographic reagents, wood and paper pulp, and many other liquids. Thus, they are used especially in the manufacture of tanks, vats, and containers in contact with acid and alkaline chemicals and also where they are in contact with products which must be protected from discoloration. For many purposes, e.g. building, the Monel nail is considered superior to stainless-steel nail.

Monel, stainless-steel, copper, brass, and bronze-alloy nails are used when nail corrosion and rust formation are to be prevented and the particular applications require the use of the relatively expensive metals. The advantages of aluminum-alloy nails are principally their freedom from staining and rusting, while costing less than copper-base-alloy, Monel or stainless-steel nails. Their light weight is another advantage. The fact that almost three times as many aluminum-alloy nails as steel nails are contained in a pound makes the use of aluminum-alloy nails both practical and feasible where their limitations in strength are not detrimental. In accordance with FHA requirements, aluminum-alloy nails must be etched. The etching process removes dirt, grease, and oil from the nails and roughens their surface.

Nail Point

The selection of the proper type of nail point depends upon the nail use. The point can be of influence on both the nail-holding power and the splitting resistance of wood into which the nail is driven.

The majority of nails are provided with regular diamond points. The gradual taper of this point causes the nail to hold well without splitting the less dense woods during driving. Dense woods are better nailed with blunt-pointed nails. They pierce the wood fibers rather than spread them, thus, prevent splitting the wood. For fast nailing, long diamond points and needle points, shaped somewhat like a sharpened pencil, may be used. These sharp points allow the nail to be set before driving and penetrate quickly without too great an effort. The round needle points do not tear or break, but spread the material to be fastened, thus are particularly desirable in nailing fabrics such as carpets. The chisel point, resembling a screw-driver point, eases large nails through hardwood. V-shaped points, similar to chisel points, however with a grooved end, are still more effective than blunt diamond points in preventing splitting of dense wood. The duckbill-pointed nail is used for holding thin materials which might split during driving. The latter point is used when nails are to be clinched; that is, if the point is to be bent over after having penetrated the wood. This point is self-clinching if used with a backing or clinching plate. The side point, with off-center tip, is another point which is particularly suitable for clinching in nailing hard woods.

In general, a nail with a long sharp point may have greater holding power than one with a blunt or medium long point. The effect of the point design on the driving resistance and holding properties of nails is, however, relatively small and, thus, often practically insignificant from the strength viewpoint. Clinching can improve the holding power of a plain-shank nail. The use of nails with properly grooved shanks having similar or even greater holding power may, however, be more practical and economical and assure more uniform and reliable strength than attained by clinching.

Nail Head

The selection of the type of nail head is also governed by its end use. The nail may be headless, have a small brad head as in the case of finishing nails, or a countersunk head as in the case of casing nails to accommodate flush countersunk nailing with minimum head holes in the finished item. In these cases, the frictional resistance between nail shank and wood is almost the only means which can prevent the nail from being pulled through. The larger resistance to pull through is required, the larger the head has to be. Thus, for nailing somewhat soft materials, such as asphalt roofing, gypsum sheathing, and insulation boards and felts, extra large heads may be specified. For fastening of insulation padding, spiral-wire heads have been developed which are more economical to manufacture than the extra large flat heads otherwise required.

Fig. 2. Some nail points

For special purposes, round, oval, cone, and hook heads are used. Duplex headed nails are particularly suitable for temporary use, such as in scaffolds and framework when the nails are pulled after having fulfilled their purpose. The head surface may be flat, cupped to accommodate nail setting or checkered to provide a large surface area. The head can be slotted to allow turning of the nail with a screw driver or to simulate a screw head.

The nail head may be provided with a small or generous fillet between head and shank to prevent pulling of the nail head from the shank. Underneath the head, small fins may remain from the heading

operation during manufacture. These fins may be satisfactory from the application viewpoint. On the other hand, under certain conditions, they may crack the material to be fastened, such as asbestos shingles, or enlarge the nail hole with detrimental effect. Thus, nails with smooth surface underneath their heads may be specified under given conditions.

Nail Shank

Most nails are made of round wires, although triangular and square wires are used for a limited number of special nails.

Chemical etching of the nail surface can increase the nail-holding power. This increase is, however,

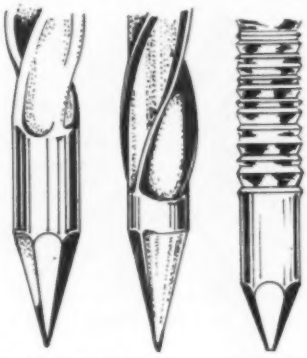


Fig. 3. Samples of pilots for grooved nail shanks

only of a temporary nature since moisture in the wood, both when the nail is driven and if occurring later, results in chemical digestion of the wood fibers in contact with the nail.

Barbing of the nail shank can decrease the resistance to withdrawal if the barbed nail is pulled immediately after driving. However, barbing can be beneficial when limited moisture changes occur in the dry wood into which the nail was driven.

Triangular- and square-shank nails can be twisted or nails can be made of twisted triangular or square wire in order to provide threaded shanks offering increased holding properties. In the latter case, the nail shank is of necessity twisted all the way from head to point.

In order to attain maximum holding properties, spiral, helical or annular grooves may be rolled onto the plain-shank nail. The groove shoulders may consist of single or have both primary and secondary shoulders of different heights with varying upsets, clearance and tooth angles. The groove roots may be rounded or flat. The groove spacing and groove angle may vary. Thus, a comparison of groove-shank nails is only feasible if consideration is given to the variations in groove design.

Helically grooved nails with long pitch turn as they are driven into wood. The grooves displace the wood fibers and form a thread in the wood. Thereby, the surrounding fibers are compressed and the frictional resistance between wood and shank surface is increased. These nails can grip wood so tightly that, during forced nail extraction, the nail shank may even be counter-twisted in its reverse direction.

When annularly grooved nails are driven into wood, the fibers are forced over the ring shoulder into their annular grooves like wedges to be released only when the wood is destroyed or decayed. Because of the piercing action of these nails, they may even penetrate encased knots during driving.

Grooved nails may be provided with a clearance, that is, a plain unthreaded portion of the nail-shank between head and grooves. No benefit can be derived from grooves embedded in the piece of material to be fastened. Thus, the length of the clearance is best determined in such a way that it extends throughout and slightly beyond the depth of the piece to be fastened. Then, a full shank section exists where maximum flexural and shear stresses may be found.

A spirally or helically grooved nail provided with a proper clearance may hold the item to be fastened tighter than the same nail without a clearance. If, as a result of the clearance, no threads can grip the wood fibers of the piece to be fastened, the nail can freely turn itself into the wood to which the piece is fastened and, thus, pull the two pieces tighter together. Hence, for example, the unthreaded portion of the nail can turn freely in the top hardwood flooring strip, while the rest of the nail shank threads itself into the softwood sub-flooring plank. Thus, final driving of the nail with proper clearance can pull the top and sub-flooring tighter together than is possible with a nail threaded up to the head.

For ease in initial driving of nails with grooved shanks, a short pilot may be used; that is, for a short length from the nail point the nail shank is plain and grooving starts only beyond that length. A short pilot does not have any appreciable influence on the nail-holding properties of properly grooved nails. However, a pilot can decrease the holding properties of unsatisfactorily grooved nails, since the full nail-shank section of the pilot may prevent groove shoulders of insufficient diameter from forming the desired spiral or helical grooves in the wood into which the nail is driven.

Nail Treatment

Low-carbon-steel nails may be blued by heat treating and, thus, sterilized for sanitary reasons. High-carbon-steel nails may be hardened, that is, heated, oil quenched, and tempered in order to increase their stiffness and strength.

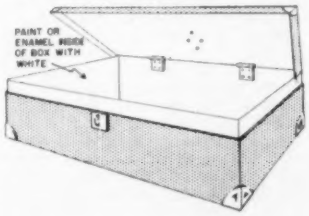
In order to protect steel nails from corrosion, they may be hot or electro galvanized; that is, provided with a continuous zinc coating. Thus, under severe exposure conditions, a properly galvanized nail is expected to last from two to three times as long as a non-coated low-carbon-steel nail.

Nails can be copper, nickel, tin or cadmium plated with coatings which, if properly applied, can be as effective as a thick zinc coating in making the nails corrosion resistant. Thin coatings are so ineffectual as rust preventives that they are regarded practically as ornamental finishes. One reason for this is that the deposit is not thoroughly homogeneous and galvanic action between the two metals takes place. This is especially true of copper on steel. A heavy deposit remedies this, but to attain effectiveness would cost too much, or much more than a heavy hot-zinc coating.

To provide limited corrosion resistance, nails can also receive a phosphate dip-coating containing oxidizing agents. Cement-coated nails have a resinous coating which is designed to be melted by the frictional resistance produced during penetration of the wood by the coated nail shank. The melted resin is to provide a bond between the nail shank and the surrounding wood fibers. Such bonds, if stronger than the friction between nail shank and wood, may increase the withdrawal resistance of nails immediately after driving, as may be the case if cement-coated nails are driven into light woods. This increase, as attributed to cement coating, however, drops off in the heavier woods to practically no advantage over non-coated nails. The initial increase in withdrawal resistance may partly disappear in time, particularly if the nails are driven into green or partially air-dry woods. Cement coating apparently has no appreciably beneficial effect on the withdrawal resistance of grooved nails.

TOOL BOX

BY PAINTING THE INSIDE surfaces of a tool box with white paint or preferably white enamel, as shown, small tools will be seen more readily. This is especially helpful when working in poorly lighted areas.



How To Work Combustion Problems

Importance of basic theory . . . Chemical symbols used by Combustion Engineer . . . Colored marbles . . . Combustion Engineering shorthand . . . Air for combustion . . . Steps in the solution of combustion problems . . . Value of continued practice in solving combustion problems

By FRANK S. DRECHSLER

Mechanical Engineering Department, University of Delaware, Newark, Del.

MANY COMBUSTION problems may be worked out by means of formulae. If, however, the formula fails to apply to our immediate problem, or if we wish to picture clearly the complete combustion process, we must go back to basic theory.

Often basic theory is not understood. One reason for this may be the wide use of chemical symbols by the combustion engineer. The fundamentals of combustion problem theory, however, are based only on a little common sense and a fair background of arithmetic; so that an average high school student should be able to understand them without difficulty. Take for example the following, which is nothing else but a *combustion problem in disguise:*

If you had four red, six blue and a number of grey marbles, all of which are of the same size, but made of different material, so that each red marble weighs 12 lb, each blue 2 lb, and each grey 137 lb; and if you were to arrange these in such a way that beside each red marble you put one grey and beside each blue marble you put one half of a grey marble:

(a) How many grey marbles would you need?
(b) What is the weight of all the grey marbles you used?
(c) What is the combined weight of all red and blue marbles?

The solution to this problem is shown in Fig. 1. — The total number of grey marbles used is clearly seven (each weighing 137 lb). The total weight of grey marbles is 7 x 137 or 959 lb. Also the weight of the four red marbles (12 lb each), and six blue (2 lb each) adds up to 60 lb.

If in place of red and blue marbles, we use the term *carbon* and *hydrogen*, then the colored marbles represent a hydrocarbon fuel of given composition. If the grey marbles represent the amount of air required for combustion, then the 959 to 60 weight ratio is the air to fuel ratio required for combustion of the given fuel.

Solutions to all types of combustion problems can be found in a similar manner, and as easily. This should still hold true when we replace a marble by a conventional chemical symbol.

Fig. 1. These marbles will help to explain combustion problems

The following symbols are used below:

RED MARBLES	⊗	Weight: 12 lb each
BLUE MARBLES	◍	Weight: 2 lb each
GREY MARBLES	●	Weight: 137 lb each

The following are the desired combinations:

ONE GREY FOR EACH RED

● + ⊗

½ OF ONE GREY FOR EACH BLUE

◠ + ◍

With one red marble we use one grey, therefore for four red marbles, we need four grey ones.

⊗● [1] ⊗● [2] ⊗● [3] ⊗● [4]

With one blue marble we need only ½ grey, therefore, for every two blue marbles we need one grey and for six blue marbles we need three grey.

◍◍● [5] ◍◍● [6] ◍◍● [7]

TOTAL GREY USED: 7

TOTAL WEIGHT OF RED MARBLES: 4 x 12

TOTAL WEIGHT OF BLUE MARBLES: 6 x 2

TOTAL WEIGHT OF GREY MARBLES: 7 x 137

Combustion Engineering Shorthand

Chemical symbols such as we use in combustion problems are a form of engineering shorthand. A symbol identifies a given substance, denotes a unit volume, generally a mol volume of that substance, and represents the weight, called molecular weight, of a mol volume. Table 1 lists a number of symbols that should be identified with the above properties as well as some other symbols, which are used when writing a chemical reaction, or for that matter, when describing a combustion process. In place of marbles, we deal with fuel constituents or other chemical elements. The unit size is replaced by a volume called mol volume, and naturally the weight of this unit volume will again depend on the substance.

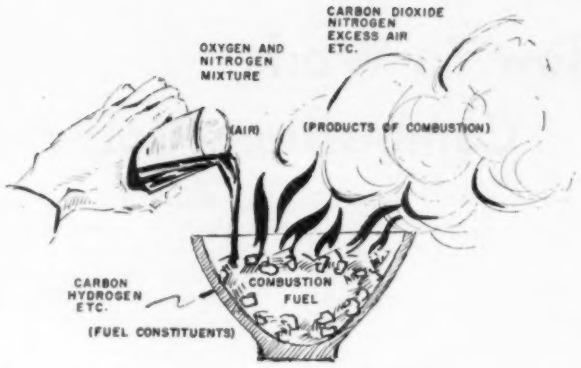
Air for Combustion

Combustion is the chemical combination which takes place between constituents of a fuel and oxygen. Theoretically, this combination can take place only in a definite manner.

Table II gives the number of volumes of oxygen needed for combustion of one volume of a given substance, and the number of volumes of the resultant product formed due to combustion. The conditions are similar to those set up in our problem

with the colored marbles, where, just as in the above case, only a definite combination was permissible. If now in a problem, we burn ten mol volumes of a substance, we will require ten times as much oxygen as indicated in Table II, and form ten times as many mol volumes of products of combustion.

The basic equations shown in Table II will not change if we use air for combustion in place of oxygen. Air is a mixture of oxygen and nitrogen. The nitrogen is not affected during combustion; it is left over after the oxygen combines. This is similar to the case of a mixture of iron filings and sand brought into the vicinity of a magnetic field. Only the iron filings respond. The one difference, however, is that oxygen and nitrogen in air are mixed in a definite proportion, so that with every mol volume of oxygen, there are 3.78 mol volumes of nitrogen associated with it; or for every mol volume of oxygen that we need for combustion, 3.78 mol volumes of nitrogen are left over. This is a very useful relationship, which should be remembered. Of further help is the weight relation that can be derived from the above statement. That is, for every mol volume of oxygen (or 32 lb) we have 3.78 mol volumes of nitrogen (or 3.78 x 28 lb),



which means that a total of 137.8 lb of air must be supplied, wherever there is need for one mol volume of oxygen. Fig. 2 illustrates this point.

Steps in the Solution of Combustion Problems

In combustion problems where the fuel analysis is known, three steps are suggested. These are:

I. Determine the volume relation, between constituents, for a definite weight of fuel.

II. Find, for each constituent individually, the total mol volume of oxygen required for combustion of that constituent.

III. Find the mol volumes of nitrogen associated with the total oxygen used up, and the products of combustion thus formed.

From the above, we can write the complete combustion equation (as a mol volume relation). Basically, this would read as in Equation I.

To illustrate our discussion an example is shown below:

For a fuel having a weight analysis C 60%; H_2 40%, determine: air:fuel ratio (ideal), air:fuel ratio (actual), when 50% excess air is supplied:

Step I — The fuel analysis as given may be read as follows: In 100 lb of fuel, there are 60 lb of Carbon and 40 lb of Hydrogen. As a molecular volume of Carbon weighs 12 lb (Table I), in 100 lb of fuel there are 5 molecular volumes of Carbon (60/12). Similarly, as a mol volume of hydrogen weighs 2 lb, we will find 20 mol volumes of hydrogen in 100 lb of the given fuel.

Step II — 5 (C) need 5 (O_2)
(From Table II)
20 (H_2) need 10 (O_2)
Total mol volumes needed 15 (O_2)

Fig. 2. Combustion of fuel

Using ○ to represent oxygen, and ⊗ to represent nitrogen, air would be illustrated by:

[○⊗⊗⊗⊗]

$[(O_2) + 3.78\ (N_2)]$

32 lb + 105.8 lb

137.8 lb total

(Sometimes the relation 20.9 (O_2); 79.1 (N_2) is used. Note that this still means 1 (O_2) for 79.1/20.9 = 3.78 (N_2)

TABLE I

Chemical Symbol 1 Mol Volume	Substance	Weight of 1 Mol Volume	Color Code
(C)	Carbon	12 lb	red
(H_2)	Hydrogen	2 lb	blue
(N_2)	Nitrogen	28 lb	black
(O_2)	Oxygen	32 lb	white
(CO_2)	Carbon Dioxide	44 lb	
(CO)	Carbon Monoxide	28 lb	
(CH_4)	Methane	16 lb	
(H_2O)	Water	18 lb	

Other Symbols:	Meaning of Symbol.
+	Combines with or Reacts with
=	Forms

TABLE II

Mol Volume of Substance	Number of Mol Volumes of Oxygen Req. for Comb.	Mol Volumes of Products Formed due to Reaction	Chemical Equation
(C)	(O_2)	(CO_2)	(C) + (O_2) = (CO_2)
(C)	½ (O_2)	(CO)	(C) + ½ (O_2) = (CO)
(H_2)	½ (O_2)	(H_2O)	(H_2) + ½ (O_2) = (H_2O)
(N_2)	Does Not Burn	(N_2)	(N_2) (N_2)
(CO)	½ (O_2)	(CO_2)	(CO) + ½ (O_2) = (CO_2)
(CH_4) or (C + 2 H_2)	2 (O_2)	(CO_2), 2 (H_2O)	(CH_4) + 2 (O_2) = (CO_2) + ½ (O_2) = (CO_2)

The parentheses are used around one mol volume of the substance.

Step III — TOTAL NITROGEN ASSOCIATED *3.78 x 15 mol volumes* of (N_2)

Step II already gives the air:fuel ratio. 15 (O_2) used, means we had to supply 15 x 137.8 lb of air, (see Fig. 2), for combustion of 100 lb of fuel.

The combustion equation could be written as Equation II, below.

[FUEL CONSTITUENTS] + [OXYGEN NEEDED FOR COMBUSTION] + [ASSOCIATED NITROGEN I] + [OXYGEN IN EXCESS + ASSOCIATED NITROGEN II] =

MINIMUM AIR — EXCESS AIR

= [PRODUCTS OF COMBUSTION] + [TOTAL NITROGEN] + [EXCESS OXYGEN] or

= [PRODUCTS OF COMBUSTION] + [ASSOCIATED NITROGEN I] + [EXCESS AIR]

Equation I

[5 (C) / 20 (H_2)] + [15 (O_2) + 3.78 × 15 (N_2)] + [7.5 (O_2) + 7.5 × 3.78 (N_2)] =

[FUEL] + [OXYGEN NEEDED] + [ASSOCIATED NITROGEN] + [50% EXCESS AIR] =

AFTER COMBUSTION

[5 (CO_2) / 20 (H_2O)] + [3.78 × 15 (N_2)] + [7.5 (O_2) + 7.5 × 3.78 (N_2)]

[PRODUCTS] + [NITROGEN LEFT OVER] + [EXCESS AIR]

Equation II

As we have the volume relation for 100 lb of fuel, we also have the weight relation. (For we know the weight of every volume in the above equation from Table I.)

Note that for 100 lb of fuel:

a. 15 (O_2) represents the total oxygen needed for combustion
b. 15 x 137.8 lb of air are needed for combustion
c. 7.5 (O_2) represents the excess oxygen supplied
d. 7.5 x 137.8 lb of excess air are supplied
e. 5 x 44 lb of (CO_2) are formed.
f. 20 x 18 lb of (H_2O) are formed.
g. The DRY PRODUCTS by volume are: 5; 15 x 3.78; 7.5; 7.5 x 3.78; mol volumes.
h. The % CO_2 in the DRY PRODUCTS is: 5/sum of mol volumes from "g."
i. The DRY PRODUCTS BY WEIGHT are: 15 x 3.78 x 28; 7.5 x 32; 7.5 x 3.78 x 28; 5 x 44 lb.

The complete combustion equation, as may be seen from the above, will yield all the results that are necessary for solution of any specific combustion problem.

In conclusion it should be said that the working of combustion problems is largely a matter of practice. At first, the method outlined above may take a little longer than substitution into formulae, but with practice it becomes equally simple.

Electricity and the Eye

Effects of Electric Currents on the Human Eye . . . Cataract of the eye due to electric current . . . Effects of the electric arc on the eye . . . Protection of eyes from electric arcs

By DR. W. SCHWEISHEIMER

IT HAS been known for quite some time that an electric current may produce a cataract of the human eye. A cataract is a disease of the eye which consists in the loss of transparency of its lens. All light has to pass through the lens, and if it becomes opaque, blindness is the result. The opacity is usually very gradual, an average period of ripening of a cataract is about two years.

Cause of Cataract

Dr. J. G. Bellows has reported on cases of cataract in human beings as a result of direct current, high voltage alternating current, lightning stroke and electric shock therapy. A recent survey by Drs. K. and L. Daily mentioned at least 80 cases as recorded in the literature. Cataracts have also been produced experimentally in animals by the passage of an electric current through the eye without the development of any other abnormality.

It is not clear whether the cataracts caused by the electric current resulted from the electrolysis within the eye tissues after the passage of the current, or whether heat effects produced in the eye were responsible. There have been described a few cases of cataract supposedly due to electricity in which the current did not pass through the eye.

The cataracts resulting from the passage of an electric current through the eye have a variable period until development. Dr. David G. Cogan says, the period is usually a matter of several months, but in one case at least it was reported to be as long as eleven years; the latter cataract was caused by lightning. These cataracts may remain stationery for a long period but are usually progressive.

The best known treatment for cataract is the operative removal of the opaque lens after the cataract has ripened. After the removal of the lens it is necessary to provide the patient with an artificial lens, that means, with glasses having convex lenses like the natural lens. The operative treatment of the cataract is a highly successful therapy.

Electric Arc and Eye

Arc flash, usually an eye inflammation (conjunctivitis) of both eyes is caused by excessive exposure to the welders' electric arc. It is characterized by delayed onset, duration of 24 hrs, red eyes, swelling of the lids, slight sunburn of the face, production of tears, dread or intolerance of light and a feeling of sand in the eyes. Electric welding has largely replaced riveting and bolting for assembling metal shapes in industry.

Modern arc welding practice is a highly specialized branch of the electrical industry. A typical case of

arc flash has been described by Forrest E. Rieke, Medical Supervisor, Oregon Shipbuilding Co. In a typical case the workman leaves the job in a healthy condition. He is unaware that he has received an eye injury until he has been at home for several hours. The day shift man usually wakens at midnight or later with painful, sandy, swollen eyes. The workman is rarely sick during the shift in which he has received the ultraviolet overdose from the electric arc. Arc flash is not due to the single bright flash but rather to an accumulated strong exposure.

Story about the Arc Flash

It is commonplace for workmen, Dr. Rieke says, to enter the eye treatment room seeking treatment for arc flash. Examination reveals normal eyes. The workman tells this story: "I have no pain, but I was working near a welder a few minutes ago when he struck an arc. I'm sure I was flashed, so I want some of that medicine put in my eyes which you use to prevent arc flash trouble."

However, there is no such preventive medicine.

The treatment is directed toward relief of local pain, redness, heat, intolerance of light and sandy feeling. In severe cases pain-relieving medicines are needed. For control of electric arc flash protective devices have been employed: flash goggles with side guards, helmets, welding clothing, screens surrounding the welder at work. Personal experience is most important, repeaters are few and they usually have been caught off guard. It has occasionally been necessary to change the location of work for certain very blond or red haired workers from shops in which they were constantly bombarded by radiation from nearby welding operations; they are particularly sensitive to such effects of electrical energy.

The most important exposure to radiant energy is that of ultraviolet, infrared, and intense visible light radiation from electric welding areas. The protective devices for controlling these exposure are effective, as we see from a list in Gafafer's "Manual of Industrial Hygiene." (See accompanying table.)

A recent survey of about fifty cases of electric ophthalmia (flash burn of the eyes) was made by Dr. L. K. Woodward. Goggles and hoods, he says, give adequate protection against this accident. By proper care all signs disappear in most cases within 24 hr, and almost certainly within 48 hr.

Dr. C. E. Benson stated that it is not the welder who is the most frequent victim of his own electric arc but the workman engaged in work *near* him. The welder protects himself with a hood. He may, however, receive a flash injury from another welder's arc, or from his own "accidentally struck" arc while his hood is raised. Minimal safe distance to a welder's arc without protection by goggles is estimated as 200 ft.

Protection Required for Electric Arc

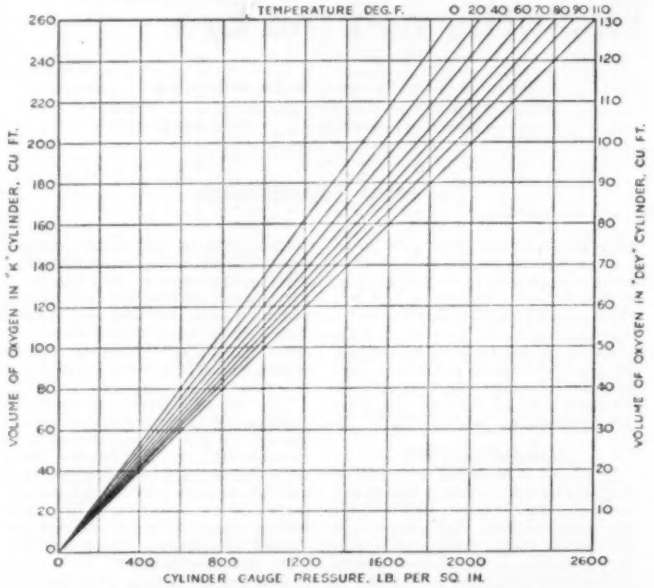
Operation	Protection
Production welding at a permanent location	Permanent shield with proper density light filter; helmet or hand shield with proper density light filter; or goggles with proper density lens.
Working in the vicinity of a welding operation	Goggles or spectacles with No. 3 or No. 4 shade lens
Light gas cutting and welding, light electric spot welding	Goggles or spectacles with No. 5 shade lens
Gas cutting, medium gas welding, arc welding up to 30 amps	Helmet, shield or goggles with No. 6 shade filter glass
Heavy gas welding, arc cutting, welding between 30 and 75 amps	Helmet, shield or in some cases goggles with No. 8 shade filter glass
Arc welding and cutting between 75 and 200 amps	Helmet or shield with No. 10 shade filter glass
Arc welding and cutting between 200 and 400 amps	Helmet or shield with No. 12 shade filter glass
Arc welding and cutting above 400 amps	Helmet or shield with No. 14 shade filter glass

HOW DOES COLD AFFECT OXYGEN PRESSURES?

DID YOU know that heat and cold affect oxygen pressures? When unused cylinders of oxygen are stored outdoors in cold weather they may show pressures of less than 2200 pounds until they warm up to room temperature.

Do not be concerned about this. The oxygen has not been lost — it is still in the cylinder. It works just like the mercury in a thermometer. Heat expands the mercury and it rises in the glass tube. When it is cold the mercury contracts and falls to the bottom of the tube but not a bit of the mercury has been lost.

The oxygen stored in cylinders for cutting and welding works in a similar way. Cylinders are filled at the

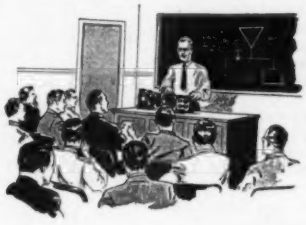


How to Estimate Oxygen Volume in "K" and "Dey" (Linde) Cylinders

This chart will show within 5 to 10 cu ft the oxygen volume in a cylinder at any ordinary temperature. Locate the point on the chart where the vertical line (cylinder gage pressure) crosses the diagonal line (temperature) and then follow the horizontal line to read the figure at the left side for "K" or the right for "DEY" cylinders. If, for example, the oxygen pressure in a K cylinder reads 1400 psi and the room temperature is 60 F, the approximate volume of oxygen in the cylinder is 160 cu ft. Note: Use left hand scale for "K" cylinders and the right hand scale for "DEY"

charging plant to a pressure of 2200 pounds per square inch at a temperature of 70 degrees F. When a full cylinder stands outdoors with the temperature at 20 F, the pressure may be only about 1900 pounds per square inch, but it will still contain the full amount of oxygen.

If you want to estimate more exactly the volume of oxygen in your cylinders at temperatures between 0 and 110 F, the accompanying chart will enable you to do it quickly and easily. It was designed by Linde Air Products Company, and is quite accurate.



Basic Power Plant FIGURING

By WILLIAM H. ENGELMAN

Mechanical Engineer, Department of Water & Light,
City of Cleveland, Ohio

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How to Use the Power of 10 in Figuring Power Plant Problems

IN STUDYING engineering textbooks and handbooks and magazines, and in a great deal of the scientific literature you run across, you often see statements like this:

"There are 26×10^6 Btu in a ton of such and such kind of coal"; or, "the mass of an electron is 9.10×10^{-28} grams"; or "the velocity of light is 1.86×10^5 miles per sec or 2.9978×10^{10} cm per sec."

"What," you have asked yourself, "in the name of all that's holy, does that 10^{10} business mean? What does that 10^{-28} mean and why *minus* 28?" and so on?

Or you may see this; $(2.0 \times 10^5) \times (7.5 \times 10^5) = 15 \times 10^{10} = 150{,}000{,}000{,}000$

Here's what it all means:

1. It is a very convenient way of expressing very large numbers in a simpler way, so they don't look so formidable to handle. That 10^6 merely means 10 multiplied by itself 6 times, or the 6th power of 10; that is, 1 with 6 zeros after it; thus: — 1,000,000.

2. In various types of figuring, as in large Btu values, or certain figuring in electricity, the processes of multiplying and dividing can often be made much easier by using these powers of 10. It means simply one extra, very simple step in the arithmetic.

3. By proper use of this simple step, you can quickly get a very close approximation to the answer, without a great deal of laborious multiplication and long division of big numbers, with all the chances for error therein.

(By the way, this method of using the powers of 10 is exactly what you are doing when you use a slide rule.)

There's nothing hard about it. One of the objects is to express a big number in terms of an integral number and, if necessary, its additional decimal, all times some power of ten.

This extra step in the mechanics transforms the operator's understanding from a very narrow view to an all-encompassing view — a quick and fairly accurate estimate of the probable answer in one glance.

The processes involved utilize the powers of 10 in a unique manner:

$10^0 = 1$; $10^1 = 10$; $10^2 = 100$; $10^3 = 1000$; $10^4 = 10{,}000$; etc.

Note: Any number other than zero affected by a zero exponent equals 1, thus:

$$\frac{10}{10} = \frac{10^1}{10^1} = 10^{1-1} = 10^0 = 1; \quad \frac{a^n}{a^n} = a^{n-n} = a^0 = 1$$

An interesting feature is that the powers of 10 denote the number of zeros after the 1, or the number of places to the right of 1 to move the decimal point—also:

$1/10 = 10^{-1} = 0.1$; $1/100 = 10^{-2} = 0.01$; $1/1000 = 10^{-3} = 0.001$; $1/10{,}000 = 10^{-4} = 0.0001$; $1/100{,}000 = 10^{-5} = 0.00001$; etc.

In this case the power tells the number of places to the left of 1 to move the decimal point. Also note that the algebraic sum or difference of the exponents indicates the power of 10 in the answer.

$$10^1 \times 10^{-2} = 10^{1-2} = 10^{-1} = 0.1$$
$$10^2 \times 10^{-2} = 10^{2-2} = 10^0 = 1$$
$$10^2 \times 10^2 = 10^{2+2} = 10^4 = 10{,}000$$

Now to make use of this knowledge, let us take practical examples:

1:— $195{,}458 \times 754{,}221 = ?$

First take 195,458 and divide and multiply by enough powers of 10 to reduce the value to 1.95458; we do the division, but only indicate the multiplication like this:

$$195{,}458 \times \frac{10^5}{10^5} = 195{,}458 \times 10^5 \times 10^{-5} = 1.95458 \times 10^5$$

$$754{,}221 \times \frac{10^5}{10^5} = 754{,}221 \times 10^5 \times 10^{-5} = 7.54221 \times 10^5$$

Now we have: $1.95458 \times 10^5 \times 7.54221 \times 10^5$
or approximately $2.0 \times 7.5 \times 10^{10} = 15 \times 10^{10} = 150{,}000{,}000{,}000$.
Actually it is 147,418,528,218; the correct answer.

2:— $0.00363 \times 0.000833 = ?$ To simplify we first operate upon the values to modify the numbers to unity times a power of 10.

$$0.00363 \times \frac{10^3}{10^3} = 0.00363 \times 10^3 \times 10^{-3} = 3.63 \times 10^{-3}$$

similarly $0.000833 \times 10^4 \times 10^{-4} = 8.33 \times 10^{-4}$
which gives $3.63 \times 10^{-3} \times 8.33 \times 10^{-4}$ or $3.63 \times 8.33 \times 10^{-7}$
approximately 0.0000030; actually 0.00000302379, the correct answer.

3:— $1{,}013{,}829 \times 0.0000563 = ?$
$1{,}013{,}829 \times 10^6 \times 10^{-6} = 1.013829 \times 10^6$
$0.0000563 \times 10^8 \times 10^{-5} = 5.63 \times 10^{-5}$
$1.013829 \times 10^6 \times 5.63 \times 10^{-5} = 1.013829 \times 5.63 \times 10^1$
approximately 5.63×10^1 or 56.3, actually 57.0785727. answer.

4:— $5{,}280 \times 0.000\,000\,29 = ?$
$5{,}280 \times 10^3 \times 10^{-3} = 5.28 \times 10^3$
$0.000\,000\,29 \times 10^7 \times 10^{-7} = 2.9 \times 10^{-7}$
$5.28 \times 10^3 \times 2.9 \times 10^{-7} = 5.28 \times 2.9 \times 10^{-4}$
approximately 15×10^{-4} or 0.0015, actually = 0.0015312. answer.

5:— $3.75 \times 10^9 = 3.75 \times 1{,}000{,}000{,}000 = 3{,}750{,}000{,}000$

6:— $375 \times 10^{-9} = 375 \times \frac{1}{10^9} = 375 \times \frac{1}{1{,}000{,}000{,}000} = 0.000000375$

7:— The tensile strength of steel in PSI $= 6 \times 10^4 = 60{,}000$ psi.

8:— The velocity of light in miles per second $= 186 \times 10^3 = 186{,}000$ mps

9:— Total area of earth in square miles $= 1.96 \times 10^8 = 196{,}000{,}000$ sq. mi.

This operation is not a panacea for multiplication and division drudgeries; it is only a rapid and close approximation of the final answer and just another weapon to use in conquering mathematics.

Please note that the outlined steps are made useful in the multiplication of three and more terms and that, since division is multiplication by the reciprocal, all steps are equally valid for division.

Quick Start Procedure For Steam Turbines

IN SOME areas it is necessary to shut relatively large turbine-generators down at night and start them up again every morning. To start such machines rapidly it is necessary to follow certain well defined procedures. In New York City, the Consolidated Edison Co. uses the following procedure for starting up two 60,000-kw, 1800 rpm 200 psi, 550 F machines in a matter of 15 minutes.

The fundamentals to be observed in quick starting of turbines after overnight shutdowns are (1) to be certain before admitting steam that the spindle is running true to within a mil, and (2) that the steam inlet temperature is approximately 50 to 100 F above the stream chest metal temperature.

The two 60,000-kw machines subjected to this quick starting procedure are connected to a common steam header system, so that with normal cooling on an overnight shutdown the temperature relation of the incoming steam and steam chest is just about ideal as shown on the accompanying chart.

These two new 60,000 kw General Electric Co. condensing units with induction and extraction points were placed in service in October 1948 and March 1949. Thermocouples were installed on one of the two units to study the rate of metal temperature change throughout the whole rolling time. As a result of this study the total rolling time was reduced from 1½ hr to 15 min on all start-ups where the shutdown time is less than 10 hr. Prior to rolling the unit with steam the auxiliaries are placed in service and both primary and secondary jets of the main evactors in conjunction with hogging jets are used to obtain the maximum vacuum possible, which is generally 24 to 26 in. of mercury. Steam seals are used on the high pressure gland and water seals at the exhaust gland. The extraction and induction valves are closed and remain closed during the start-up. Differential expansion, vibration and eccentricity recorders are observed and carefully followed while starting and accelerating the unit. By controlling the governing valves, acceleration is maintained at a constant rate so that speed is reached within approximately 15 min after the start, at which time the unit is synchronized and immediately loaded to 15 Mw and thereafter at 1.0 Mw per min.

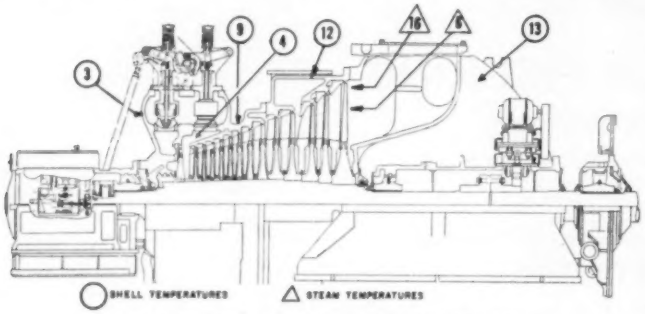


Fig. 1. Cross section of 60,000-kw turbine at Waterside Station

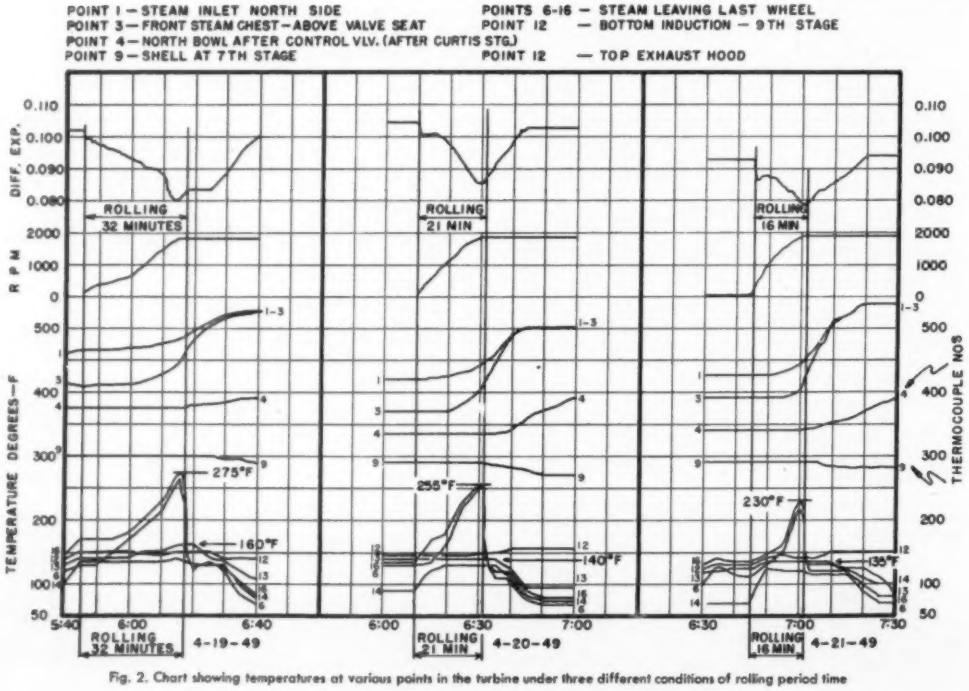


Fig. 2. Chart showing temperatures at various points in the turbine under three different conditions of rolling period time

The Engineer and Fire Hazard

By A. E. RICHARDS

PLANT and institutional fire prevention and fighting equipment should have high priority on an engineer's curriculum. This grim gremlin stands always right at our elbow in all factory, business and residential premises, waiting only a little lapse or chance to destroy. Prevention, and fighting in the initial stages are the phases which concern us, more especially since in most industrial plants the chief engineer and the local fire chief are one and the same individual.

Biggest fly in the ointment is Jno. Q. Public's carelessness, it adds up to actual laziness: an extinguisher hasn't been recharged for a year or so but would probably squirt if needed; little motor sparks brightly, it looks pretty too; lead wires on the polisher or drill have worn bare, let it go, can't hurt the drill anyway; I have collected charred bits of towel which had been draped over a toaster to dry, with the current on; paper and cloth shades used on electric lamps are a deadly menace; lint, fuzz and dust swept into a corner greedily await a casual butt, a spark from nailed boot on metal, bare wire of anything electric. One tiny spark started the biggest fire that ever raged.

Commercial cleaners, waxy floor compounds, wiping rags are a potential menace. I once helped to search twenty minutes for the source of a definite smoke odor, we finally combed out from a corner behind a door a two-gallon can half-full of floor cleaner into which somebody had tossed a butt. When moved outside it burst into flame. Guess how long it might have stood before that deadly burst.

Cause of one fire was definitely traced to 25-year-old armored cable. The insulation between sheathing and wires had deteriorated to failure point and the armor melted into a cute little metallic icicle. Yet it probably couldn't have been located before the fire without a Geiger counter.

Prevention Measures

Provide prominent NO SMOKING signs and ENFORCE THEM, wherever more than ordinary hazard exists, and where carpentry or painting is done, where any inflammable liquids are used or stored.

Place plenty metal ashtrays wherever smoking IS permitted. Eight or ten-inch glazed drainage tile inverted like the old-fashioned umbrella stand, fitted with a metal tray, gives good service, hard to upset and easily emptied.

Discard paperboard and wooden and wiremesh wastebaskets, use solid walled metal units only. Clear these daily.

Remove sawdust, wastepaper, all inflammable scrap to fire resistant storage or entirely out of the premises at the end of each working day. (Paper has so little monetary value that it is hardly worth the hazard and the labor of packaging, probably should go straight to the incinerator.)

Allow no storage of oily dirty wiping rags, wiping mops, in corners, boxes or cupboards. Mops must stand on handle end or hang on a hook.

Burn all empty paint containers. Wipe or scrape accumulations from the outside of partial empties and seal them. Keep brushes, solvents, thinners in a closed metal cupboard only. Overalls worn by painters to be hung in metal lockers with clear space between each garment.

Never overfuse a circuit, or improvise fuses in any way.

Do not overoil motors. It will creep and greatly weaken insulation, is a fine dust collector where sparking can produce fire.

All insulated leads which might be rubbed or scuffed should be placed in armor or a conduit.

Oil storage rooms, cafeteria, kitchen should have handy a fireproof blanket. (Local Fire Marshall advises the preparation of such a blanket by soaking in solution of: 1 lb. Ammon. Phosphate, 2 lb. Ammon. Chloride, in 1½ gallons water.)

Heaters, toasters, ironers which might inadvertently be left alive, should have red pilot light showing plainly when current is on. A line of high wattage lights should remain always burning in corridors and hallways, can be seen in very dense smoke as a guide to safety.

Never allow boxes or cans or impedimenta to stand in exits or stairways. Think of falling headlong over just one in heavy smoke and other folk piling right on top of you! This has often happened fatally.

Do not tamper with fire equipment. If apparently defective report to local chief or to chief engineer, the latter can have it attended to in any case. Read carefully all fire placards

"Your wife sent me down to get your reaction first—"

and notices, all the instructions printed on each type of extinguisher, especially how to use it in action. Memorize location of extinguishers, of alarm stations, and the proper way to send an alarm. AND DO NOT REMOVE FIRE EXTINGUISHER FLUID FOR USE AS DRY CLEANING MEDIUM. This is often done.

When Fire Does Come

FIRST THE ALARM. Seconds are vital. Follow it up by phone, for the best electric system will fail sometime and this may be it. Page 1 of the directory shows Fire-Police calls, or advise Operator to report Fire at your address.

Never shout "Fire!" or talk loudly, or run, or show undue alarm. Panic has killed more people than has actual fire. Immediate action with extinguishers. Use bucket, wet towel-blanket-rug. Close doors and windows to stop draft and spread of smoke-fire. If fire is near elevator, close it up and do not use. The shaft will act as a chimney to spread danger.

Evacuate staff and residents via nearest servicable elevator, by stairs, or by fire escape. Those with fire training might help to good advantage. Ready extinguishers and hose on floors above-below and in adjacent buildings. Turn off gas cocks, at source if possible. Grease, oils, fats blaze is best smothered by fireproof blanket. (Water will only spread it floating ablaze on the surface.)

If sparks catch in clothing press out with the fingers. NEVER RUN! This will fan it into instant flames. With clothing afire lie down, lie still or roll.

You are fighting a non-heroic rearguard or delaying action till men and machines arrive who can handle it much more efficiently. They won't be long. I have known rigs arrive from their station half a mile away within one hundred seconds of the alarm. Then just do as you are told, though there is no law against initiative and good judgment anywhere anytime.

The Meaning, Application and Measurement of pH

This simple explanation of pH and its use was prepared by the Water Conditioning Department of The Allis-Chalmers Mfg Co. It tells you what pH means, how you can use it in controlling the treatment of boiler feed-water, and also, it tells you how pH values are measured

WATER is seldom neutral. Usually it is alkaline and occasionally it is acid. The amount of alkali or acid present can be determined by analysis and is reported as total alkalinity or total acidity. In addition to the quantity measurement, however, there is also an intensity measurement of acidity and alkalinity; this is called the "pH value" of the solution.

A neutral condition exists when this pH value is 7.0; i.e., the solution is neither acid nor alkaline. When the pH value falls below 7.0, it indicates a greater *intensity* of acidity. When this value exceeds 7.0, it indicates a greater *intensity* of alkalinity. Thus pH is a number which indicates the *intensity* of either acidity or alkalinity of a water solution.

To illustrate that pH is not a quantity measure, Table I shows different pH values of common acids and alkalies — all at concentrations of 100 ppm. As an example, a solution containing 100 ppm of carbonic acid has a pH of 4.6, whereas a solution with the same amount of sulfuric acid has a pH of 2.8. This difference is due to the fact that sulfuric is a *stronger* acid than carbonic. Likewise it can be seen that a solution containing 100 ppm of bicarbonate of soda has a pH of 7.7, whereas the same quantity of caustic soda in solution has a pH of 11.4. This shows that caustic soda is a *stronger* alkali than sodium bicarbonate.

This scale adopted to show intensity of acidity or alkalinity (pH value) is somewhat misleading, for a change of 1.0 pH actually means that the intensity (either acid or alkaline) is multiplied by ten. This is more clearly shown by Table II, in which pH 7.0 is given a value of 1.

Application of pH

In the treatment of water for power plant or industrial use, many processes are controlled according to the pH value. Table III lists the ranges found most suitable for some typical

TABLE I Showing the variation in pH when 100 ppm of different materials are added to pure water

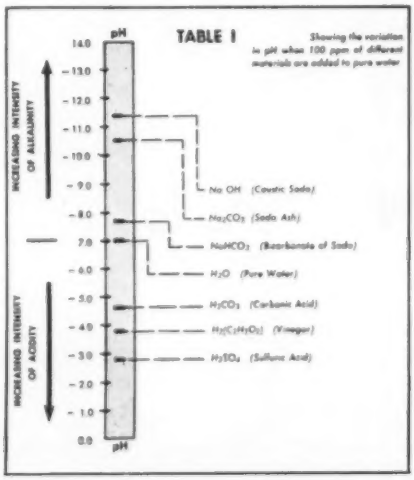
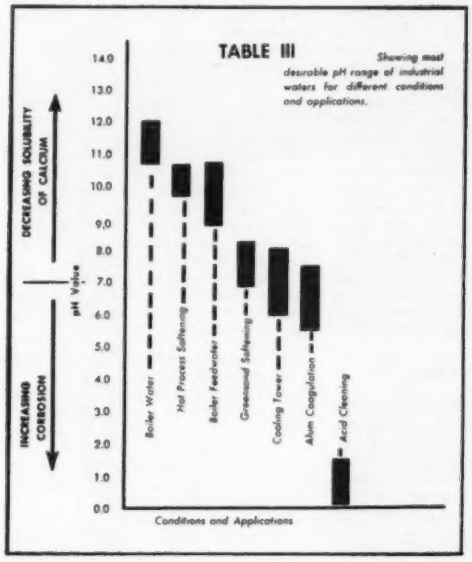


TABLE II

pH Value	Values Showing Intensity of Alkalinity and Acidity
14	10,000,000
13	1,000,000
12	100,000
11	10,000
10	1,000
9	100
8	10
7	1
6	10
5	100
4	1,000
3	10,000
2	100,000
1	1,000,000
0	10,000,000



operations. In general, the rate of corrosion increases as the pH decreases. It should be also noted that the solubility of calcium decreases as the pH increases.

Boiler water is usually maintained at a pH of 10.5 to 12.0 to minimize corrosion and permit complete internal softening reactions and produce a *fluid* but *insoluble* sludge. In most cases the softening materials used will bring the boiler water to the proper pH range.

For most complete precipitation of calcium and magnesium in hot process softeners, pH values are controlled between 9.8 and 10.5. Lime and soda ash usually permit operation within this pH range without the use of additional alkaline materials. When a hot phosphate softener is used to obtain "zero" hardness, a pH of approximately 10.5 is required to obtain greatest utilization of the phosphate.

When corrosion is present in boiler feed lines, pumps and economizers, corrective measures include control of feedwater pH between 8.8 and 10.5. When sodium sulfite is used as an oxygen scavenger, maintaining the pH in this range permits most rapid and complete reaction with the oxygen.

Where natural green sand softeners are contemplated, the pH of the *raw* water is of vital importance. Natural green sand is stable only between pH values of 6.8 and 8.2, and deterioration can be expected outside this range.

In the treatment of water for cooling towers, pH is important in the control of both scale and corrosion. The pH should be low enough to permit operation at reasonably high hardness concentrations without scale deposition, and yet high enough to prevent excessive corrosion. Based on individual conditions, a pH range of 6.0 to 8.0 frequently meets these requirements.

When oil is removed from water by filtration, the pH should be maintained between 5.5 and 7.5, the most favorable zone for proper coagulation with alum. The pH is adjusted when necessary by changing the ratio of alum to alkali.

In the acid cleaning of boilers, a pH of 0.1 to 1.5 will permit most rapid disintegration of acid-soluble scale.

These are typical examples of the role of pH in modern plant operation. Many other processes exist in which pH plays an important part.

Measurement of pH

Two basic methods exist for determining pH, electrometric and colorimetric. The most precise method of pH measurement utilizes a specially designed pH meter, suitable chiefly for laboratory use. Generally, colorimetric methods are completely satisfactory for control of pH in the majority of plant operations.

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOUR QUESTION about some problem in operation, maintenance or design will be published, signed only with your initials.

Answers to your questions from other readers will be sent you as soon as received, then published as space permits, so that all may have the information.

You, too, answer questions from other engineers in the same way. You get paid well for published answers and also get the credit for knowing them.

If other engineers help you solve your problem, you express your thanks, via the Q & A editor.

Simple, isn't it? And effective! Just ask engineers who have tried it!

Answer No. 484

WILL MIXING SAWDUST WITH COAL IN BUNKER INCREASE FIRE DANGER?

WE DISPOSE of our wood waste — about one-half car per week — by distributing it over the coal in a concrete bunker or into a 20-ft-diameter silo approximately 70 ft high, located outside our boiler plant, said C.E.B. in the May issue.

This wood waste is sawdust and shavings from our dust collector system in the pattern shop. It improves the handling qualities of the coal and offers no firing problem in the stokers.

Our steam generating plant consists of three 60,000-lb-per-hr Type A boilers, fired by spreader-type, continuous-ash-discharge stokers. We store our coal in a 400-ton concrete coal bunker, which discharges into a weigh larry.

What we want to know is: Will this wood fuel, mixed with coal, increase or decrease the possibility of a fire resulting from spontaneous combustion? said C.E.B.

Get CO_2 Gas or Dry Ice Ready and Stop Worrying, Says Al

I HAVEN'T the slightest idea what the answer to this question is, but it seems to me that C.E.B. does not need to worry too much about it anyway.

Nowadays it is perfectly possible to rig up a CO_2 system or to use dry ice to put out a bunker fire if it does start from spontaneous combustion. It seems to me this is the most economical thing to do. It costs a lot in wages to put out a fire, and it costs

money for the fuel that gets burned up.

It would not be too difficult to run piping to several points in the bunker, connect them up with a cylinder of CO_2 and inspect the bunker every once in a while for hot spots. If one develops, just shoot in some of the CO_2 and blanket the fire.

Another way of doing it has been used very successfully by Consolidated Edison Co. of New York. They experimented with dry ice and found it a quite satisfactory and economical means for fighting bunker fires.

For the average fire they use about 1 lb of dry ice for every 2 or 3 tons of coal in the bunkers. They put the dry ice in holes about 3 ft deep in the coal and then cover it with the coal. As the dry ice evaporates, the CO_2 gas is released and extinguishes the fire.

C.E.B. should be sure that if he has gates at the bottom of the bunker discharging into the weigh larry, those gates will be practically air tight when closed. It has been noted in a good many cases that leakage of air up through bunker gates and into the coal has much to do with starting of spontaneous combustion. The theory here is exactly the same as it is in an outside storage pile, which is compacted and rolled to eliminate air spaces and air passage through the pile. It seems to me the same thing applies in a bunker.

However, one of the most important points of C.E.B.'s question is his comment that mixing of the sawdust and shavings with the coal improves the handling qualities of the coal and presents no firing problems in the stokers. This should encourage other engineers who have similar wood waste to try the same thing on spreader stokers.

I mention this because there is always a great deal of argument among engineers about the advisability of burning wood and coal together in the same furnace. Here is evidence that when your wood waste is perfectly dry, as it must be coming from the pattern shop, finely divided and mixed with the coal in this way, it can be done. On the other hand, if the wood waste is wet and in larger form that this, some other method of burning it would have to be tried. There are a number of successful ways of doing this.

Chicago, Ill. AMBITIOUS AL

Answer No. 485

HERE'S AN OLDIE—CAN VERTICAL STEAM ENGINE RUN WITHOUT CYLINDER LUBRICATION?

OLD-TIMERS have told him, said Ambitious Al in the May issue, that they have heard of vertical steam engines being operated without cylinder lubrication, although they can't show him one. He asked for information on how and if it is done. He thought it was important, for there are many cases where a steam engine would give just the right service if its exhaust were oil-free and the way to get it oil-free is to avoid putting the oil into the steam in the first place.

Well, here are some comments from a man who has operated vertical engines without cylinder lubrication. Some of them, he says, ran that way for 20 years. Hear our good friend, John C. Porter. Also, Badger and Eckert put their oars in. Everybody points out that it was always done with saturated steam and that in modern engines, using much higher temperatures, you must lubricate.

He Operated Them Years Ago, Says Porter

EARLY IN my career I had occasion to work with vertical steam engines — simple, compound, and triple expansion — all of which had operated for 20 years or more without cylinder lubrication. These engines all ran with saturated steam at pressures up to 195 psi and gave no indication that lubrication was necessary in the cylinder. There were times, however, particularly with large D slide valves, when these valves would get a little noisy, and we would introduce a small amount of graphite mixed with kerosene, in a lubricator provided for this purpose.

The whole secret of operating engines in this way, I believe, is to start them out originally without lubrication. The cylinder walls and rings take on an extremely high polish, which is as smooth as glass, and appears to resist wear approximately 100 per cent.

Another factor in favor of these large engines was relatively slow piston speeds of less than 500 ft per min, combined with the fact that they did operate on saturated steam and of course got some lubrication from the water present in the steam.

Since my experience with large vertical steam engines, I have had occasion to operate a number of small vertical type engines driving various power plant auxiliaries, but have never run one that did not have cylinder lubrication throughout its life. I personally believe, however, that small vertical engines with valves of the piston type, and operated at comparatively slow speeds with moderate steam pressures, will give good service without cylinder lubrication. They also have to be supplied with saturated steam, and be very thoroughly broken in at a slow speed when first started up.

Rock Hill, S. C. JOHN C. PORTER

They Used To Do It, But Conditions Have Changed

LONG AGO, oil for cylinder lubrication was rarely used on engines, either vertical or horizontal. Cylinders were lubricated by water from the steam, which was usually quite wet after a long trip from the boiler without superheat.

With the coming of superheat, oil became a requirement for long ring and cylinder life. However, there is a condition which would make water lubrication possible even with moderate superheat. This condition depends on the piston and valve being at an average cylinder temperature, which is usually below the saturation temperature for incoming steam. Hence water will form on the surfaces of valves and rings, and if clearances are uniform, will stay there.

Assuming that an engine could be water lubricated, note the changes that have occurred since this was common practice:

1. Engine speeds are higher. Pressures are higher.
2. Very few saturated steam or low superheat engines still exist.
3. Piston ring and valve designs are different.
4. Unaflow engines are more common. These run with the cylinder heads very hot.
5. As a result of using oil on superheated engines, it was noted that oil is a better lubricant than water. It improves the operation and increases the life of any engine when used with the steam.
6. You will probably do less maintenance overall if you continue to oil your cylinders and clean the oil from the condensate.

Catawba, W. Va. WARREN BADGER

Yes, It Can Be Done, Says Eckert, But Will It Pay?

THOSE OLD TIMERS are right when they say that some engines have been operated without cylinder lubrication. Most cases, I think, you will find were marine engines. No doubt some cases can be found in stationary engines.

The main point, I think, in running engines without cylinder lubrication was to get uncontaminated condensate and to a lesser extent save money in engine operation. The second reason, no doubt, is rather erroneous.

An engine running with a friction load of say 10 per cent would, without proper cylinder lubrication, have an increase of 2 or 3 per cent friction load. This would call for additional steam to carry the engine. In addition there would be increased cylinder wear and ring wear. This adds to the cost of engine operation.

I might point out that turbine drives, either direct or geared, have largely supplanted engine drives.

I would also like to point out that, a good many times, oil troubles in systems are the result of improper attention to separating equipment in use.

In summary, it would be possible to use an engine without cylinder lubrication where the overall economy will pay for it.

Mt. Vernon, Ill. ALBERT R. ECKERT

Fig. 1. Typical recent design of 2-stage non-condensing steam ejector

Keep Your Steam Jet Ejectors Up to Snuff

Follow these instructions and keep your ejectors working right, pulling the same vacuum they did when new . . . If they don't, here's what to do about every detail . . . How to find whether trouble is in system or ejector . . . How to dismantle and repair ejector . . . How to check nozzles and diffusers for wear and what to do if you find it . . . Precautions in re-assembling ejector . . . Tip-offs on trouble . . . What you can do in emergencies, when you can't shut down, to keep ejector performance stable . . . All this from one who knows

By L. S. STINSON, Heat Transfer Dept., Elliott Company

WHEN A STEAM JET EJECTOR produces an unsatisfactory vacuum after having produced a satisfactory vacuum for a number of months or years, it is the maintenance man's job to find out why, so that he can make the necessary changes or repairs to recover satisfactory vacuum.

First step is to make absolutely certain that there has not been a gradual and unobserved change in operating conditions, so that the ejector is now being operated on conditions different from design conditions on which it was formerly operated.

Check the operating steam pressure at the ejector steam chest with a steam pressure gage that has just been accurately calibrated from about 20 lb lower to about 20 lb higher than the expected operating steam pressure. This will make sure that the operating steam pressure has not dropped below the pressure for which the ejector was designed. The steam gage normally used may now be out of adjustment and not show this.

For example, supplying a recently-installed steam-using unit of equipment from the same steam line as the ejector may have caused a drop in the steam pressure in the line. Or an old unit of equipment fed from the same steam line as the ejector may be using considerably more steam than it formerly did, so that the steam pressure in the line is reduced. Also, check the temperature of condensing water entering the intercondensers, if the ejector is a condensing type, to make sure it does not exceed the maximum design temperature and that the difference between entering and leaving water temperatures for each intercondenser is that recommended by the ejector manufacturer (this differential is usually 10, 12 or 15 F).

Check the exhaust steam line handling steam discharged from last stage, to make certain that pressure against which the last stage now discharges has not been increased. If the end of this line is submerged a few inches in a hot well, see that this submergence has not been increased by a recent rise in level of water in the hot well. This submergence should never be more than 6 or 8 in. See Fig. 4.

These methods were given recently in *Powerfax* and the author then gave the following specific directions on what to do next.

System or Ejector?

If operating conditions are correct, next step is to see if the cause of the trouble is in the ejector or in the system it serves. Isolate the ejector, either by closing a valve in the vapor line to it (this is one of the reasons ejector manufacturers strongly recommend installing a good tight closing valve in the suction line) or by disconnecting the suction line and bolting a blind flange to the suction opening of the ejector. Now try operating the ejector on no load.

If it pulls up to an appreciably higher vacuum than it ever maintained, even when new, on the system, and this vacuum is steady, the trouble is in the system and not in the ejector. The system should be water-tested or air-tested to find air leaks, checked for recent overloaded operation, or for excessive gas in a new feed stock, etc., so that conditions causing excessive overload on

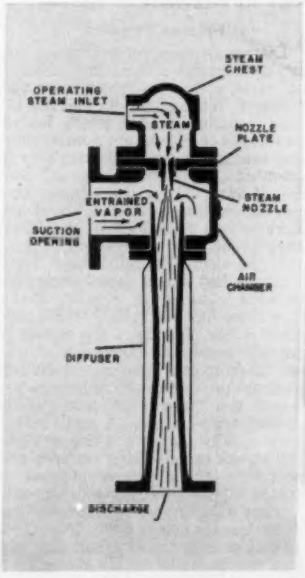


Fig. 2. Diagram of an ejector stage, showing names of parts and illustrating operating principle

the ejector can be suitably corrected.

If the ejector on no-load operation pulls up to an appreciably higher vacuum than it ever maintained on the system, but this vacuum is not steady, the trouble may still be in the system and not in the ejector.

This particular ejector may be one that was not designed and built to be stable at shutoff vacuum, that is, on no-load operation. Ejectors, particularly single-stage ones, are sometimes designed this way, when the purchase specifications do not call for the ejector to be stable up to, and at, shutoff vacuum, because this permits the ejector manufacturer to use less steam for operation at the guaranteed load.

However, these ejectors, if in first-class condition, will produce a steady shutoff vacuum if operated on a steam pressure approximately 10 per cent higher than the design steam pressure, or when handling a small amount of gas, say approximately 20 per cent of the gas they were guaranteed to handle.

Note particularly that this 20 per cent factor applies to all the gas, including water vapor, which a single-stage ejector was guaranteed to handle. But it applies only to the air or non-condensable components of the gas and not to any of the condensable vapor, such as water vapor, which a multi-stage ejector was guaranteed to handle.

This amount of air can be admitted to the ejector by drilling a small hole in the blind flange bolted to the suction opening. Size of hole to drill can be determined by taking the 20-per-cent air component to be admitted, in pounds per hour, dividing it by 895, and using the answer as area of circular hole in square inches. Pick the size drill that gives a hole having an area closest to this.

If the ejector, on no-load operation, when operated on about 10 per cent higher steam pressure or when handling about 20 per cent of its guaranteed air component load, does pull up to a high steady vacuum, the trouble is in the system and not in the ejector. But if it does not pull up to a high steady vacuum, the trouble is in the ejector and the following steps are suggested.

Ejector Repairs

Dismantle the ejector to check for foreign deposits in it, scaling of internal parts, and wear in the nozzles and diffusers. While steam jet ejectors almost invariably have much longer service life than vacuum pumps, they will eventually erode, particularly if operated on wet steam, and will corrode if handling corrosive gases (and most gases from process systems are more or less corrosive), so that they must eventually be repaired.

If the ejector is multi-stage, start with the last stage, usually the first to need cleaning or repairs. Make sure there has not been a steam leak through the threads of the nozzle in case the nozzle has loosened a little in service from continual expansion and contraction, due to the difference between the "in-service" and "shut-down" temperatures. A small steam leak usually leaves a white or light tan streak on adjoining surfaces and will soon cut a groove because of steam wire-drawing through the leak.

Face off any grooved surfaces and then use a new nozzle washer or gasket enough thicker than the original one to make up for the amount faced off. Look through both ends of the nozzle, with light from a flashlight shining in the opposite end, and make sure the nozzle is completely free from scale, is smooth and clean — not pitted, grooved, or cut. If the operating steam being used has some entrained solids in it, a fine film of scale will sometimes form on the throat of the nozzle and there is usually a thicker deposit, which is much easier to see, just beyond the throat.

Clean out any scale with a scraper and smooth up any rough spots by running a long narrow strip of fine emery cloth gently back and forth through the nozzle. If a nozzle is badly chewed up on the outside from the impact of corrosive gases, so that the exit end is not smooth all around, check its length with the original length obtained from the ejector manufacturer. If the exit end has been eaten away so that the nozzle is not as long as it was originally, discard it and order a replacing nozzle.

Clean out any foreign deposits in the air chamber and make certain the air chamber is not cracked, rusted, or corroded enough at any point to cause an air leak. Look through both ends of the diffuser, with a flashlight shining in the opposite end, and make sure the diffuser is completely free from scale, is smooth and clean, particularly the inlet end and the throat, and is not pitted, grooved, or cut.

Clean out any scale in it with fine emery cloth, if possible. If you have to use a scraper, try to keep from marring the metal. Then smooth up all rough spots with fine emery cloth. After a few years' service, scale will be deposited on a diffuser, sometimes $\frac{1}{32}$ to $\frac{1}{16}$ in. thick, if the operating steam or the vapor handled has mechanically-entrained solids in it.

If the throat of the diffuser is much out-of-round, or if inlet portion and throat of the diffuser are rough and pitted all over as if they had been sandblasted; or if they are grooved all around with long narrow grooves running parallel with a center line through the diffuser, starting about the center of the inlet portion and extending down into the throat so that it looks as if someone had been jabbing at the inside of the diffuser with an ice pick, and these grooves are so deep that they cannot be removed without much difficulty by using fine emery cloth, the diffuser is probably so badly worn it cannot be used and will have to be replaced.

If the ejector is a condensing type, clean the intercondensers and make certain all parts are in good condition. If the ejector has been handling mixed gases that may include a little vapor, such as fatty acids, naphthalene, and the like, which congeal at relatively high temperatures, some vapor passages in the intercondensers or tail pipes may be clogged with congealed material, which will have to be steamed out.

If an intercondenser has a spray nozzle, make sure it is in good working condition and is not clogged, loose, or out of place. If the exhaust steam line from the last stage, see Fig. 4, is submerged 6 or 8 in. in the hot well and "hard" water, such as some well water, is used for condensing purposes, check for scale deposit at about the water level in the hotwell.

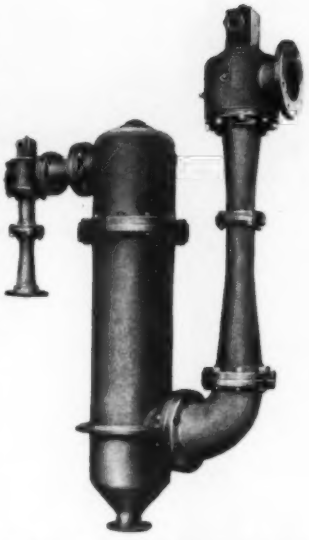


Fig. 3. Typical recent design of 2-stage condensing steam jet ejector

Nozzles and Diffusers

After all stages and intercondensers have been cleaned up, next step is to take the nozzles and diffusers, which have been cleaned and polished, and carefully measure the throat diameters as accurately as possible on several different axes to catch any out-of-roundness. Then compare these with the original throat diameters, which the ejector manufacturer will supply upon request.

If either nozzle or diffuser throat diameter of an ejector stage, or both, are larger than original throat diameters, calculate both original and present throat areas in square inches and determine percentage increase in areas. In calculating present areas of out-of-round throats, use smallest diameter measured to calculate diffuser throat area.

If percentage increase in nozzle throat area is equal to or larger than percentage increase in diffuser throat area, and largest percentage increase is $7\frac{1}{2}$ per cent, or less, the ejector stage will probably work reasonably well, but not as well as when it was new. If largest percentage increase is between $7\frac{1}{2}$ and 15 per cent, the ejector stage may work, but will probably produce a somewhat poorer vacuum than it did when it was new, and the vacuum may fluctuate a little.

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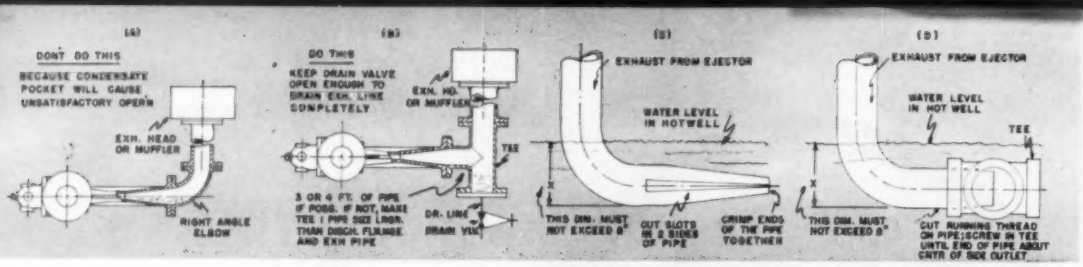

(A)
DONT DO THIS
BECAUSE CONDENSATE POCKET WILL CAUSE UNSATISFACTORY OPERN
EXH. HEAD OR MUFFLER
RIGHT ANGLE ELBOW
(B)
DO THIS
KEEP DRAIN VALVE OPEN ENOUGH TO DRAIN EXH. LINE COMPLETELY
EXH. HD. OR MUFFLER
TEE
3 OR 4 FT. OF PIPE IF POSS. IF NOT, MAKE TEE 1 PIPE SIZE LRGR. THAN DISCH. FLANGE AND EXH PIPE
DR. LINE
DRAIN VLV.
(C)
EXHAUST FROM EJECTOR
WATER LEVEL IN HOTWELL
X
THIS DIM. MUST NOT EXCEED 8"
CUT SLOTS IN 2 SIDES OF PIPE
CRIMP ENDS OF THE PIPE TOGETHER
(D)
EXHAUST FROM EJECTOR
WATER LEVEL IN HOT WELL
TEE
X
THIS DIM. MUST NOT EXCEED 8"
CUT RUNNING THREAD ON PIPE; SCREW IN TEE UNTIL END OF PIPE ABOUT CNTR OF SIDE OUTLET

Fig. 4. Installation tips for ejectors, showing exhaust details that can affect operation

A — If you do this, condensate pocket will make trouble. B — Connect the exhaust like this, so it will drain properly. C — In hotwell, this arrangement of exhaust pipe will reduce rumbling and spatter. D — Here's another good way to reduce hotwell rumbling and spatter. Note dimension X in C and D

If largest percentage increase is more than 15 per cent, the ejector stage probably will not work satisfactorily enough to be of much use, and the nozzle and diffuser will have to be replaced with new ones before satisfactory operation can be expected. Even if the percentage increase in area is only 5 per cent, it is highly advisable to order a replacing nozzle and diffuser so as to have them on hand when subsequent wear makes it impossible to use the old one. The possible effects of wear as outlined above are based on the throats of the diffusers being only slightly out-of-round, and on inside surface of the diffusers being smooth. Roughness, pits, or bad out-of-roundness will materially increase the adverse effect of a given amount of wear.

If percentage increase in the diffuser throat area is larger than percentage increase in nozzle throat area, the ejector stage will not work satisfactorily until the nozzle is redrilled. Do this so as to increase the throat diameter enough to make the percentage increase in its throat area at least equal to, or preferably slightly larger than, the percentage increase in the diffuser throat area, so as to bring the nozzle and the diffuser back into balance again.

Reason for this is that all ejector stages are designed and built so that the steam flow through the nozzle is exactly that required to produce a velocity in the diffuser throat which, when converted back into pressure by the diffuser, will result in this ejector stage discharging at the absolute pressure required for satisfactory operation. The steam flow through the nozzle depends only upon the throat area of the nozzle and the upstream steam pressure, since the downstream pressure is always considerably below critical pressure.

If wear has caused the diffuser throat area to be increased a greater amount than the nozzle throat area, the velocity through the diffuser throat is reduced so that, when this reduced velocity is converted back into pressure by the diffuser, the resulting absolute pressure is lower than that required for satisfactory operation.

This design characteristic of ejectors is the reason it is frequently possible to operate an ejector stage with the diffuser a little worn by having the minimum steam pressure at the ejector stage a little higher than the original design steam pressure. The resulting increased steam flow through the nozzle produces the necessary velocity in the enlarged diffuser throat.

Rather definite indication of a worn diffuser or of unbalance in wear between nozzle and diffuser is the fact that, as time goes on, you are forced to keep raising steam pressure on the ejector in order to get it to operate satisfactorily.

If you have to drill a nozzle throat to a little larger diameter, be sure to reround the nozzle entrance and to take out any burrs or sharp edges, left by the drilling operation, with fine emery cloth.

Re-assembly Tests

The next step is to re-assemble the ejector. If new gaskets are used, be sure the new gaskets between the nozzle plate and the air chamber and between the air chamber and the diffuser flange are not more than 1/32 in. thick. After re-assembly, test the complete ejector for air leaks. Close off enough openings to be able to fill the ejector completely full of water and note any water leaks. Or close off enough openings to be able to hold 10 to 15 psig air pressure in the complete ejector and cover all flanges with soapy water so that an air leak will blow soap bubbles. Stop any leaks shown.

Next start up the ejector and try operating it on no load or handling the 20 per cent air component load mentioned above. Start up multi-stage ejectors one stage at a time, starting with the last stage, and check the vacuum maintained by each stage before starting up the next one.

If the vacuum maintained by each stage is steady and somewhat higher than the vacuum normally maintained at that point, when the ejector was satisfactorily serving its system, the ejector should be able again to maintain a satisfactory vacuum. If the vacuum maintained by a stage fluctuates, it usually means the diffuser of that stage was a little too badly worn for the above procedure to fully compensate for the wear. Such a diffuser should be replaced with a new one.

Trouble Tip-Offs

When an old ejector starts giving trouble the recent operating history is frequently a tip-off to the possible source of the trouble. For example, if the vacuum maintained by an ejector is steady but gets a little poorer day by day, look for a steam leak through the nozzle threads, and if the ejector is a multi-stage one, the steam leak is probably in the first stage. If a multi-stage ejector seems to be getting unusually sensitive to small increases in noncondensable load, look for a steam leak in the last, or possibly the next to last, stage.

Even when operated on a steam pressure appreciably higher than its design steam pressure, if an ejector "breaks" or "coughs" with each small drop in steam pressure, look for worn diffusers. When an ejector is operating brokenly or is coughing, the vacuum not only drops badly but also fluctuates widely; and the air chamber of the stage in trouble (and the air chambers of all preceding stages of a multi-stage ejector) usually gets quite warm. This indicates the stage that is in the worst trouble.

Summing up

Wear in duffusers is more critical than internal wear in nozzles. Wear in a nozzle tends to compensate for wear in the diffuser. In case of doubt as to effects of wear, order a new diffuser first, since a new diffuser will operate with a nozzle a little worn while the effect of replacing a worn nozzle with a new one is to make operation worse if the diffuser is worn. You can operate with a worn nozzle and a new diffuser, but not with a new nozzle and a worn diffuser.

Always replace a worn diffuser with a new one; experience shows that attempted repairs to worn diffusers are unsatisfactory. Both dimensions and proportions of diffusers are critical, so that for the attempted repair to have any chance of being satisfactory, it is necessary to enlarge the inside of the old diffuser enough to permit installation of a liner, which must be accurately machined outside and inside. This rather large amount of very close-tolerance machine work makes the attempted repair more expensive than a new diffuser.

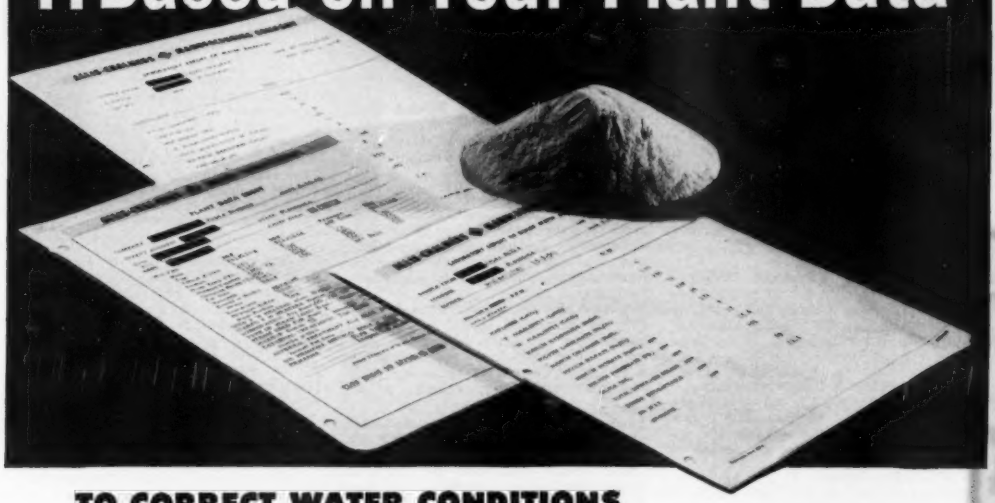
In an emergency, if you must try to keep an old ejector in stable operation — that is, without breaking on steam pressure dips — until it may be taken out of service long enough to check it thoroughly for repairs, try raising the steam pressure at the ejector to see if it will operate stably at some higher steam pressure.

If necessary, and possible temporarily, set the boiler safety valves for a little higher pressure (perhaps at night or on Sunday). If ejector operation is stable on a higher steam pressure, try, by slowly reducing the steam pressure, to determine the exact minimum steam pressure at which each individual stage of a multi-stage ejector will operate stably, starting with the last stage first, then the next-to-last stage, and so on.

Next, figure the percentage increase of minimum stable operating steam pressure of each stage expressed in pounds absolute, not pounds gage, over original design steam pressure (also expressed in pounds absolute). Then redrill the nozzle of each stage requiring higher steam pressure, to give this same percentage increase in nozzle throat area. This usually permits the ejector to operate stably on a minimum steam pressure equal to or slightly higher than design pressure.

℞ ALLIS-CHALMERS No. 30 SERIES Boiler Feedwater Treatment

..Based on Your Plant Data



TO CORRECT WATER CONDITIONS USE THE CORRECT TREATMENT

THE RIGHT PROTECTION in the right amount is given by Allis-Chalmers No. 30 Series powder formulations — protection against scale, corrosion and embrittlement (if required). The materials used, their proportions and the rate of feeding are prescribed by Allis-Chalmers specialists, and each formulation is based on the characteristics of the plant it is to serve.

There are no secrets connected with No. 30 Series treatments. These formulations are the logical chemicals in the proper proportions to control undesirable elements revealed by a study of your plant data. No stock "boiler compound" can equal this straightforward, effective internal treatment for boilers in the low and medium pressure ranges.

A trial period for a No. 30 Series treatment can be arranged for your plant if our studies indicate that it will prove helpful.

FOR A COMPLETE, BRIEF discussion of the Allis-Chalmers No. 30 Series internal treatments, send for bulletin number 28X7531. If you wish, your nearby Allis-Chalmers office can arrange to have your water problems brought before our specialists for study.

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Milwaukee 1, Wisconsin

Gentlemen:
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Company

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Water Conditioning

✓ EQUIPMENT ✓ CHEMICALS ✓ SERVICE

New ENGINEERING BOOKS

Metal Processing, by Orlan William Boston. Second edition; size 6 by 9 in.; 763 pp including index; illustrated; cloth bound. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Price $7.50.

This second edition has been revamped to bring it up to date and to provide detailed information on machine processes, accessories and tools. It gives the information needed for the complete preparation of process routings, including selection of machine tools, cutting tool materials, tool shapes, power, speeds, feeds and all accessories involved in plant layout for manufacture.

The book correlates the design of the part, the metal of which it is made, the fabricated form; and the machines and tools used in its manufacture. It has been revised to focus attention on new developments, information has been added on electric motors, hydraulic pumps, machine tool drives, sintered carbide tools and their use, and machinability; and a new chapter on surface quality has been included.

Many illustrations of basic and special machine tools, typical machining operations and comprehensive recommended practices should be of use to production, tool and design engineers.

Symposium on Ultrasonic Testing (STP No. 101). Size 5 by 7 in.; 133 pp; illustrated; paper bound. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Price $2.00.

The ten papers and discussions included in this book represent a summary of the history, theoretical aspects, basic principles of practical testing and practical applications for the ultrasonic testing of materials.

In his introduction, H. C. Amtsberg, Westinghouse Electric Corp., indicates these points: 1. Ultrasonic testing is being used very extensively today. 2. It is practical and is being applied intelligently by engineers in all branches and in a variety of industries. 3. It is not just another device which can be used for rejecting more material; it can and will aid and abet manufacturing. 4. Standard equipment is available which will perform very acceptably in the hands of non-technically trained personnel of ordinary skill.

Several of the papers include appropriate list of references and one bibliography is outstanding, constituting 342 references to the inspection, processing and manufacturing control of metals by ultrasonic methods.

Sourcebook on Atomic Energy by Samuel Glasstone. First Edition; 546 pages; 6 by 9 in.; fully illustrated; cloth; published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York 3, N. Y.; 1951; price $2.90.

This book brings together for the first time in one readable narrative the important things about the past history, present status, and possible future of atomic science. Without simplifying, without popularizing, it unfolds the spectacular, almost unbelievable story of the greatest achievements of modern science.

Much has been written about the atomic bomb and the terrors of atomic warfare. This is a different kind of book — a balanced guide to all aspects of atomic energy, in peace as much as in war. It was written by Dr. Glasstone under the auspices of the Atomic Energy Commission and at the Commission's direction, to supply the general reader, as well as teachers, scientists and engineers with an authoritative, responsible, wholly reliable volume of atomic facts. Beginning with the earliest theories of the atom and its structure, it describes the growth of thought and knowledge in the field. The development of the theories of the nature of electricity and energy, the discovery of the phenomenon of radioactivity, and so through the study of isotopes to the present culmination in great cyclotrons and betatrons, in atomic piles, man-created new elements and the release of atomic energy.

At the low price at which this book is issued, no person interested in atomic energy should be without it.

It is a clearly written, carefully organized book of lasting and vital importance to be read and re-read and to act as a constant reference in the new era we are entering — the atomic age.

The Index of Training Films; Third Edition. Size 9 by 11½ in.; 86 pp; paper bound. Prepared by Editors of *Business Screen* Magazine, 150 E. Superior St., Chicago, Illinois. Price $2.00.

Here is a comprehensive, revised listing of more than 2,900 currently available industrial and technical motion pictures and slidefilms for free loan, rental or purchase and use in business, industrial or vocational training classes or for general educational background.

Motion pictures and slidefilms are available for numerous industries: aviation, automotive, electronics, foundry and forging, machine shop, materials and metals, shipbuilding, wood and lumber, industrial relations, and many others.

Symposium on Corrosion of Materials at Elevated Temperatures (STP No. 108). Size 6 by 9 in.; 120 pp; illustrated; paper bound. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Price $2.25.

This symposium resulted from an increasing awareness on the part of metallurgists and designers that the atmosphere in which a high-temperature component will operate must be carefully considered before a suitable material can be selected. In many cases, the corrosive aspects of the service will far outweigh the mechanical factors, such as creep and stress-to-rupture.

Many of the investigations presented were stimulated by gas-turbine developments, but unquestionably the work is applicable to other high-temperature activities. The behavior of materials in atmosphere from all the common fuels for mobile and stationary power generation are discussed, ranging from leaded aviation fuels to coal. The paper on corrosion by oil ash from residual fuels has attracted special interest due to the current seriousness of the problem in many industries.

Symposium on Plasticity and Creep of Metals (STP 107). Size 6 by 9 in.; 68 pp; paper bound. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Penna. Price $1.50.

This symposium covers four phases of plastic deformation and flow of metals. The material was presented at the First Pacific Area National Meeting of ASTM in 1949.

The papers and their authors are: The Experimental Exploration of Plastic Flow in Sheet Metals by L. R. Jackson and W. T. Lankford, Battelle Memorial Institute; Forming Parameters and Criteria for Design and Production by William Schroeder, Lockheed Aircraft Corp.; The Use of Creep Data in Design by H. C. Cross and L. R. Jackson, Battelle Memorial Institute and Super Creep-Resistant Alloys by J. W. Freeman, D. N. Frey, E. E. Reynolds and A. E. White, University of Michigan.

Everyday Statistics, Facts and Fallacies, by George W. Snedecor. Size 8½ by 11 in.; 152 pp; spiral binding. Published by Wm. C. Brown Co., Dubuque, Iowa. Price $3.00.

This book is written for the general reader who wishes to learn some of the fundamentals of modern statistics. The vocational opportunities in statistics are scarcely considered, since greater emphasis is placed on the social aspects of the subject.

No mathematics beyond elementary algebra is required. The logic of the science is presented with only so much mathematical symbolism as is necessary for clarity.

Some of the chapters deal with sampling from a known population; frequency distributions; probability, games of chance; distribution of sample statistics in measurement; and sampling human populations.

Hydrodynamics, a Study in Logic, Fact and Similitude, by Garrett Birkhoff. Size 5½ by 8⅜ in.; 180 pp; cloth bound. Published by Princeton University Press, Princeton, N. J. Price $3.50.

The book is largely devoted to two special aspects of fluid mechanics: the complicated logical relation between theory and experiment, and applications of symmetry concepts.

A listing of the chapter titles will give you some idea of the contents of the book and the material covered: hydrodynamical paradoxes, recent progress in free boundary theory, modeling and dimensional analysis, group theory and fluid mechanics, and virtual mass and groups.

The relation between theory and experiment is introduced by an examination of the paradoxes which have arisen in traditional hydrodynamics. Light is thrown on these problems by the author's discussion of important new advances in free boundary theory.

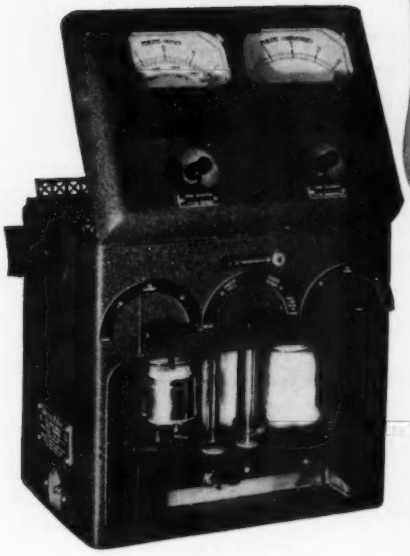
After a treatment of modeling and dimensional analysis, the rest of the book centers around applications of group-theoretic ideas, which are shown to motivate many solutions of problems involving compressible and viscous flows, and to yield the classical force equations for a solid moving through a perfect fluid.

Mechanical Engineers' Handbook. Edited by Lionel S. Marks. Size 6 by 9 in.; 2153 pp; illustrated; flexible cloth binding. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y. Price $15.00.

This revised fifth edition will help answer your troublesome questions on mechanical engineering. More than 100 engineers co-operated to produce the engineering data contained in this edition.

Significant recent developments dis-

(Continued on page 100)



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Combustion Facts Fully Revealed by Fast, Simple Heat Prover Test

This scientific combustion analyzer—the Cities Service Heat Prover—gives you the real "inside" on furnace combustion conditions. Its plain, quick, accurate work lets you know:

How much excess oxygen is present

How much combustible matter is wasted

How much fuel you might save

Without endless trial-and-error you can proceed to conserve fuel and increase furnace output. This is substantiated by records made on all types of furnaces. See for yourself how productivity can be improved. Call or write *today* for a Cities Service Heat Prover demonstration . . . readily arranged in your plant. Or for further details return the coupon below.

Not an instrument you *buy*, but a service we *supply*. Write or call us today.

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- Trojan Greases
- Trojan Gear Oils
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CITIES SERVICE OIL COMPANY
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New York 5, N. Y.

Without obligation please send your booklet, "Combustion Control for Industry" and Heat Prover information.

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Company_____

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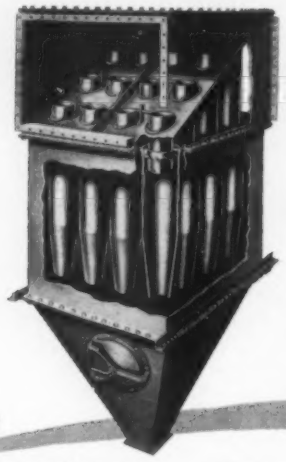
Before you buy *any* equipment for recovering dust or fly ash . . .



COMPARE ALL OTHERS against MULTICLONE'S Multiple Advantages

Because the advantages of MULTICLONE are so clear-cut, so vitally important, so far-reaching in the savings they make, we urge you to make a factual unbiased comparison of MULTICLONE dust and fly ash collection equipment against *any other* in the mechanical recovery field. Only by making such a comparison can you fully appreciate the major savings and greater performance you get by installing MULTICLONE Collectors!

COMPARE Recovery Efficiency!

It is a recognized fact that the separating efficiency of a cyclonic tube increases as the tube diameter decreases because smaller tubes generate greater centrifugal forces. The patented vane in the MULTICLONE makes the use of small tubes *practical* without complicated manifolding and permits compacting many small tubes into one simple, highly efficient unit. MULTICLONE's higher centrifugal forces throw out not only the large, medium and small particles, but also an unusually high percentage of the *extremely small* particles of 10 microns and less. Result—*more complete recovery of all suspended particles from the gas stream!*

COMPARE Space-Saving Compactness!

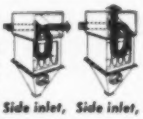
Plant space costs money—particularly at today's high construction costs. Because the MULTICLONE is more compact, size for size, it makes *really important* savings in space and plant costs. Note in the chart how the MULTICLONE requires substantially less space—*both in floor space and cubic space*—than any other unit of comparable capacity and performance. *This means vital savings in construction costs!*

Make	Relative Space Requirements In Sq. Ft.	In Cu. Ft.
Multiclone	1.0	1.0
Collector A	2.1	1.8
Collector B	5.9	2.2
Collector C	6.8	3.9

COMPARE Dollar-Saving Adaptability!

Savings in space is just one of many ways MULTICLONE reduces installation costs. Because the shape of the unit can be readily varied (long and narrow, short and wide, or square) to fit available spaces, the MULTICLONE can often be tucked into odd corners and waste areas too restricted for other equipment.

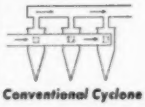
Moreover, inlet-outlet ducts can be varied—side-inlet, side-outlet, or side-inlet top-outlet—to meet low headroom or restricted side clearance requirements . . . and the single-inlet single-outlet duct design permits greater flexibility and simpler installation. *These all add up to vital savings in installation costs!*



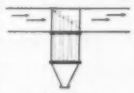
Side inlet, Side outlet *Side inlet, Top outlet*

COMPARE All-Around Simplicity!

The MULTICLONE is simple and inexpensive to maintain because there are no highspeed moving parts to repair or replace . . . no pads or filters to clean or renew . . . nothing to choke the gas flow or increase draft losses as suspended materials are recovered. In addition, the square, flat-sided shape of the MULTICLONE and its straight inlet and outlet ducts are far simpler to install and insulate. And since the recovered material from an entire bank of tubes is collected in a *single* hopper, it is much easier to service and maintain than the multiple hoppers of conventional cyclone units. *Here again, the MULTICLONE saves in many ways—all of them important!*



Conventional Cyclone



Multiclone

Whether your recovery installation is in a new structure or for modernizing present equipment, you will be far ahead by installing MULTICLONE Collectors. Our experienced engineers will gladly make helpful suggestions for simplifying your recovery problems. A letter, wire or call to our nearest office places this asistance at your service without obligation.

Send for Helpful Literature! This factual MULTICLONE literature explains the basic principles of cyclonic dust recovery and gives technical data helpful to anyone contemplating a dust or fly ash recovery installation. Write today for your free copy!

WESTERN Precipitation CORPORATION

ENGINEERS, DESIGNERS & MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

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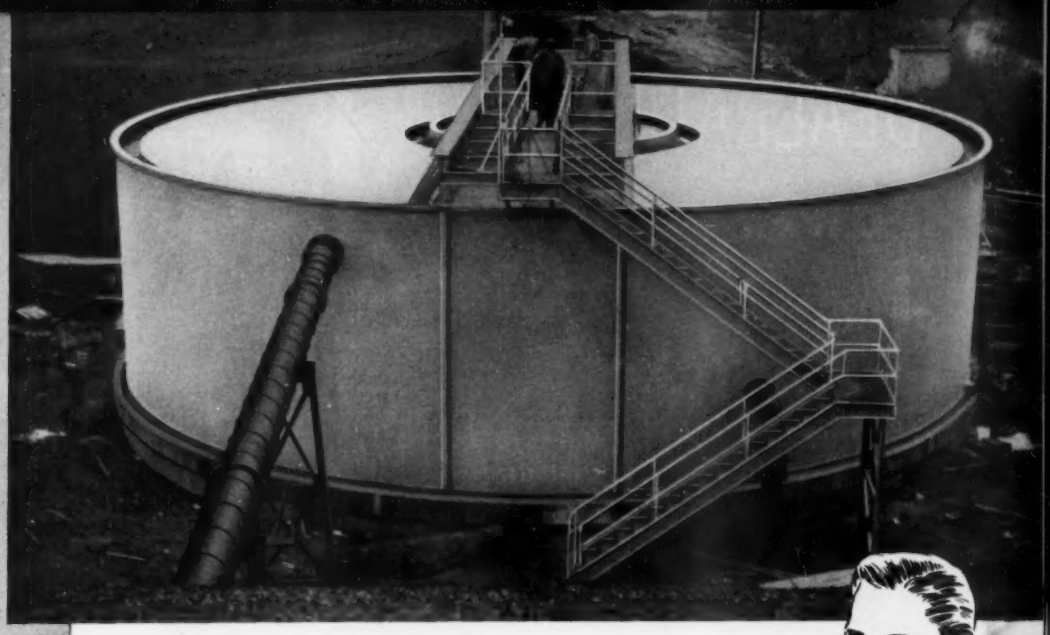
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

A *Good* waste-treatment system...



costs *far less* than you think!

HERE'S HOW ONE MAN LEARNED THIS FACT:

A paper manufacturer, faced with the problem of waste treatment in his plant, guessed that a good system would cost him a six-figure sum. To avoid paying so high a price, he sunk a considerable amount into a home-made system—which simply did not do the job. And so he called in consulting engineers.

After making a complete survey of the mill, analyzing samples of its waste, and thoroughly studying the problem, the engineers made their recommendations. They were accepted by the surprised manufacturer, and the system was built.

The waste-treatment plant cost *even less* than the supposedly-cheap makeshift equipment that had failed, and it provided an effluent completely acceptable for re-use in the mill.

It also produced some benefits the manufacturer never expected:

- **A large amount of raw stock was recovered**
- **Stream pollution was eliminated**
- **There was an important reduction in heat losses**

The manufacturer estimates the new system will have paid for itself within three years!

Maybe *you* have been putting off the question of water, sewage, or industrial waste treatment for your plant or community because you think the cost prohibitive. Don't guess; you will probably be wrong! *Call in consultants specializing in this field.*

FREE BOOKLET

FOUR WAYS TO ECONOMIZE ON INDUSTRIAL WASTES ... is a factual treatise offering much useful information on its subject. Write for your copy today! Address: Gilbert Associates, Inc., 412 Washington St., Reading, Pa.

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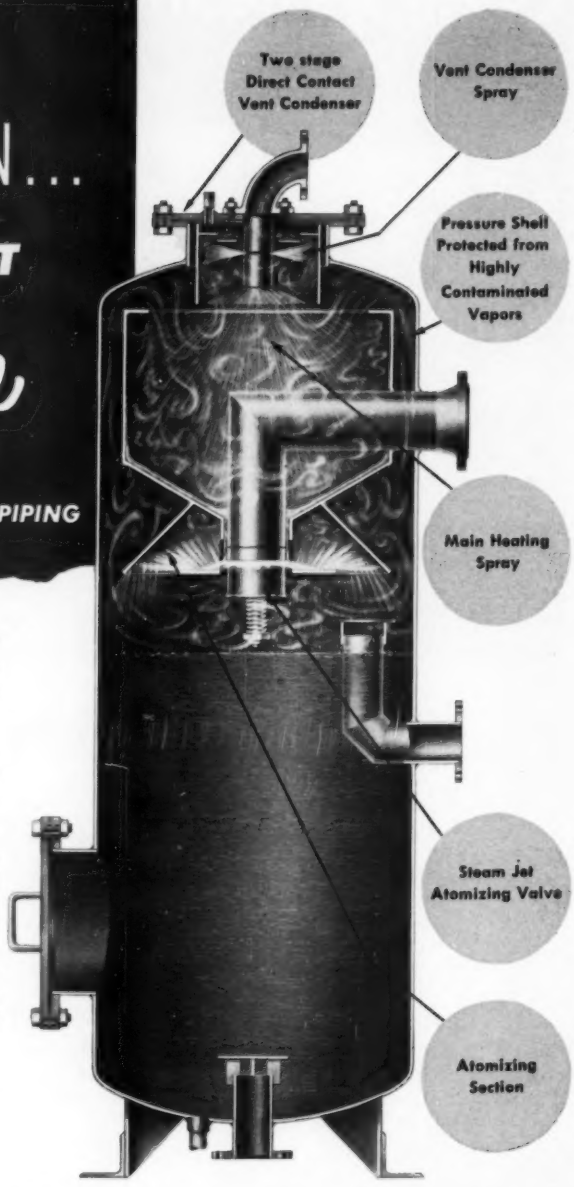
PREVENTS CORROSION IN BOILERS...ECONOMIZERS...PIPING


Two stage Direct Contact Vent Condenser
Vent Condenser Spray
Pressure Shell Protected from Highly Contaminated Vapors
Main Heating Spray
Steam Jet Atomizing Valve
Atomizing Section

This Atomizing Spray Type Deaerator ... American Engineered and Industry proven ... insures a long, trouble-free life for your boiler water system.

Deterioration of most metals through corrosion in steam power plants is a constant and expensive problem to industry. To effectively control or eliminate this deterioration of costly installations is to insure the life and efficiency of your system and protect your investment.

American Engineers, with a background of over 50 years of water treatment experience, stand ready to offer authoritative engineering guidance in the solution of your water treating problems.

We invite your inquiry ... ask for bulletin 117.

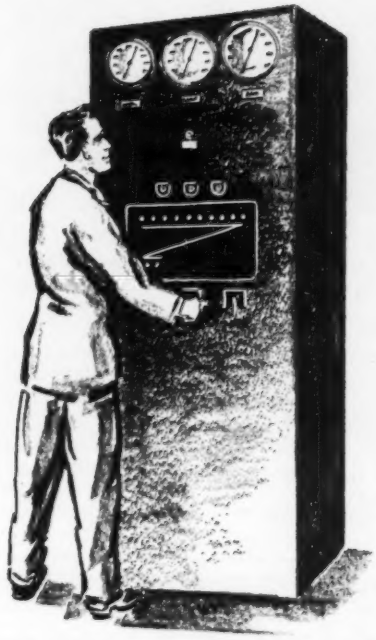
AMERICAN SYSTEM A W S Co. PATENTED

The **AMERICAN WATER SOFTENER COMPANY**

LEHIGH AVENUE & FOURTH STREET • PHILADELPHIA 33, PENNA.

FILTERS • SOFTENING SYSTEMS • CHEMICAL FEEDERS • ION EXCHANGERS • RE-ACTORS • SWIMMING POOL EQUIPMENT • DE-GASIFIERS • WATER TEST SETS • RE-CARBONATORS • ALKALIZERS

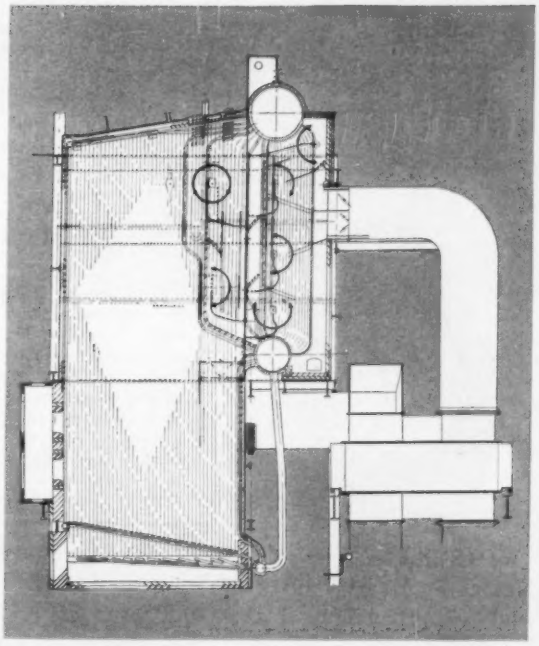
VULCAN *Automatic Sequential*
for PALATKA STATION
of FLORIDA POWER *and* LIGHT COMPANY



Pushing one button at the control panel starts the automatic sequence. Each blower signals that it cuts in and operates correctly. Operation of individual blowers can be skipped or repeated without leaving the panel.

Effective boiler cleaning at low cost was demanded for the new Palatka Steam-Electric Station of Florida Power & Light Company. Vulcan will deliver these benefits. Effective boiler cleaning will be a simple matter of pushing one button. Each blower will then work in correct sequence, applying the right amount of steam at the velocity needed. Steam will be saved, because each blower will operate for exactly the correct time. Labor will be saved, because operators will not need to climb to remote locations. Maintenance costs will be low, because each Vulcan unit is designed and built for easy inspection and repair or replacement. Write for Bulletin 483—Automatic Sequential Soot Blowing.

VULCAN SOOT BLOWER DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
DU BOIS, PENNSYLVANIA



Boiler by	Combustion Engineering-Superheater, Inc.
Type of Boiler	VUX
Capacity	350,000 pounds per hour
Operating Pressure	850 psi
Total Steam Temperature	900 F
Fired with	Oil; provision for future use of coal
Consulting Engineers	Ebasco Services, Incorporated

VULCAN *Automatic Soot* **BLOWERS**

BIDDLE

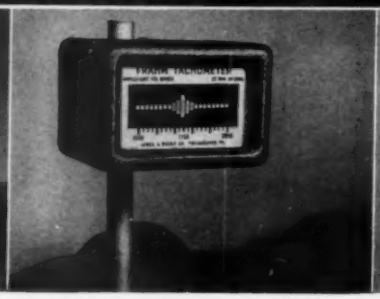
Instrument News

- ELECTRICAL TESTING INSTRUMENTS
- SPEED MEASURING INSTRUMENTS
- LABORATORY & SCIENTIFIC EQUIPMENT

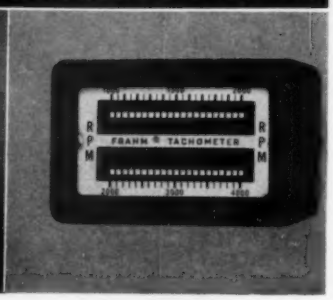
NUMBER 6 OF A SERIES

JAMES G. BIDDLE CO., 1316 ARCH ST., PHILADELPHIA 7, PA.

Type T-21



Type T-21 mounted with a Cat. 2406 Bracket



Type T-22

MEASURE SPEED BY RESONANCE—Touch or Permanent Mounting
FRAHM® RESONANT REED TACHOMETERS

The Miniature Frahm instruments shown above weigh about 12 ounces and measure approximately 3″ x 2″ x 2¾″. The T-22 affords double the rpm range of the T-21. Various speed ranges are available from 1000-1500 to 9000-13,000.

The phenomenon of resonance activates the delicately tuned reeds when touched to any part of a rotating machine or when permanently mounted. 60° or 90° brackets are furnished where mounting is desired. In confined spaces, the convenience of merely touching the instrument to any part of the machine casing is highly desirable and a considerable safety factor.

Since there are no movable parts in Frahm Resonant Reed Tachometers there is nothing to require maintenance. They are built to take rugged handling.

Frahm Tachometers are made in a variety of shapes and sizes with splash-proof cases and reeds tuned to guaranteed accuracy within 0.5%.

Write for Bulletin 31-PE.

SPEED COUNTER AND STOP WATCH COMBINED
JAGABI® TACHOSCOPE

Measurement of Speed and Time are combined in the Tachoscope in such a way that the usual error in starting and stopping is eliminated. Higher accuracy of calculation is assured because of the longer time the Tachoscope can be operated. It is a highly precisioned instrument for machine speeds up to 20,000 rpm. In fact, many use it as a standard for checking other speed measuring instruments. The high-grade stop watch can be used independently.

SPEED MEASURING BULLETIN

A selection chart of Speed Measuring Instruments for specific conditions is a feature of Bulletin 35-PE. Mailed on request.

WIDE RANGE PRECISION HAND TACHOMETER
THE DR. HORN TACHOMETER

We are now prepared to make immediate delivery of this instrument, considered by many to be the ultimate in a fine speed measuring device. Pointer affords instantaneous reading of rpm of rotating shafts, or linear and peripheral speeds, regardless of direction of rotation. Measures in six ranges from 25 rpm to 30,000 rpm. Protected against overspeeding damage. Operates equally well in a vertical, horizontal, or slanting position. Simple mechanism. Low maintenance. Long life.

James G. Biddle Co. is the sole distributor and authorized service agency for these highly regarded instruments.

Write for Bulletin 35-65-PE.

Above: Interior view of Municipal Light Plant, Madelia, Minnesota.

Right: T. C. Splinter, Superintendent (at right), checks performance of big diesel while S. C. Field of Standard Oil's Mankato office looks on.

Ailing diesels get clean bill of health

As power demands grew, so did trouble for the Municipal Light Plant of Madelia, Minnesota. Carbon formed rapidly in the plant's three diesel engines. Ports required cleaning every two to three weeks. Diesels had to be shut down frequently to free stuck rings and remove varnish from cylinder walls.

T. C. Splinter, plant superintendent, put the problem to a Standard Oil lubrication specialist. The lubrication specialist pointed out that the straight mineral oil used in the engines was not able to stand up under the severe conditions of operation. He recommended a switch to STANDARD HD Diesel Oil.

This heavy-duty lubricant made a clean sweep of the troubles. In four years of hard service, STANDARD HD has kept engines clean and rings free. Port carbon has been reduced to a minimum. Engines are now operated up to 8,800 hours before they are inspected or cleaned. Maintenance costs have been trimmed 30% to 40%.

STANDARD HD
TRADE MARK
Diesel Oil

A 1400-hp diesel engine was added to the plant in 1948. This makes a total of 2,840 diesel horsepower now protected by STANDARD HD for this plant.

The experience of T. C. Splinter indicates how you can reduce maintenance costs with STANDARD HD Diesel Oil. A Standard Oil lubrication specialist will be glad to help you obtain maximum benefits from this superior diesel oil.

Arrange for his visit, now, by phoning your nearby Standard Oil Company (Indiana) office . . . or write: Standard Oil Company (Indiana), 910 So. Michigan Ave., Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA) STANDARD

EYE-HYE
your
helps protect this
plant from the danger
of water level accidents
Accurate "liquid column" reading always visible to control station engineers
● There's small chance of your operators overlooking boiler water gages when you have a panel- or wall - mounted EYE-HYE for each boiler. This all-hydrostatic remote reading gage can be placed at any vantage point. Its illuminated green indicating fluid "reads fast" —the customary liquid column image, only brighter, sharper.
EYE-HYE is sensitive to slightest level changes. It's simple, accurate, safe, sure. Can't be tampered with; factory calibration eliminates adjustments on location. Has no mechanical working parts. Easy to install, easy to maintain. You can blow it down at intervals, to insure clean lines.
EYE-HYE is the original trouble-free gage for dependable remote water level supervision. Over 9000 in use. Write for Bulletin CO.
THE RELIANCE GAUGE COLUMN COMPANY
5902 Carnegie Avenue Cleveland 3, Ohio
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Reliance
EYE-HYE
FOR
main boilers
waste heat boilers
feed water heaters
flash tanks
water treatment systems
storage tanks
Three EYE-HYEs on panel board at The Jeffrey Mfg. Co., Columbus, O.
The name that introduced safety water columns....in 1884
Reliance®
BOILER SAFETY DEVICES

(Continued from page 92)

cussed are fluid mechanics, stresses in turbine disks, transonic and supersonic aerodynamics, aircraft jet propulsion, rockets and television. Other subjects covered are radiant and panel heating, solar heating, high-vacuum pumps, industrial supersonics, modern casting methods, statistical quality control and automatic process control.

This fifth edition also furnishes new and revised information on the materials of engineering, for example: ferrous and non-ferrous alloys, super alloys for highest temperatures, plastics, elastomers, silicones, adhesives, rocket fuels, reflective heat insulation and powder metallurgy. Power costs are analyzed in the light of current conditions, as are gas turbines and atomic energy as power sources.

The AMA Handbook of Wage and Salary Administration. Edited by M. Joseph Dooher and Vivienne Marquis. Size 6 by 9 in.; 410 pp; cloth bound. Published by American Management Assn., 330 W. 42nd St., New York 18, N. Y. Price $7.50.

Here is a guide to principles and techniques of wage and salary administration and company experiences covering major types of job evaluation and wage administration plans.

The 34 chapters of the handbook cover such subjects as: techniques of the wage survey; case histories in wage and salary administration; joint labor-management job evaluation; salary administration for multi-unit operations; selected forms for job evaluation; and results of recent research into simplified wage administration. In addition, a model manual used by Armstrong Cork Co. to explain its wage program to employees is reproduced in its entirety as an appendix to the volume.

The book is designed to meet the needs of companies that contemplate setting up a formal program of wage and salary administration for the first time, as well as those who wish to review and improve their present programs in the light of tested and up-to-date techniques.

Ion Exchange Resins, by Robert Kunin and Robert J. Myers. Size 6 by 9 in.; 212 pp including appendix and index; illustrated; cloth bound. Published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Price $4.75.

This book was written to meet the needs created by the rapid increase in the industrial and research applications of ion exchange that followed the development of high-capacity, specific and durable ion exchange resins.

The book correlates the widely scattered literature on the phenomenon, provides the scientist and engineer with helpful information on all phases of ion exchange and ion exchange resins.

This reference book presents the theory underlying the ion exchange mechanism; the usefulness of the resins; operational and engineering data; and laboratory and industrial methods of using the resins throughout the power, chemical process, agricultural, medical, pharmaceutical, sanitation and many other fields.

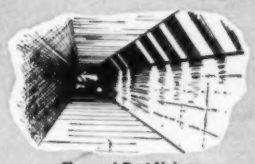
The work also includes chapters on the practical aspects of ion exchange in the recovery of metals, in sugar refining, water softening and other applications. It tabulates characteristics of commercial resins and describes the design and operation of ion exchange apparatus.

WHERE TO USE LUMNITE IN POWER PLANTS

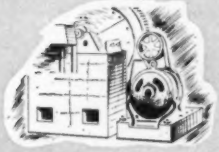
Steel Stack Linings

Ash Pit and Cinder Catcher Linings

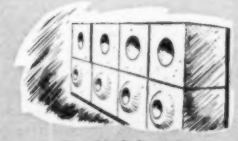
Coal Bunker Linings



Flue and Duct Linings



Overnight Structural Concrete

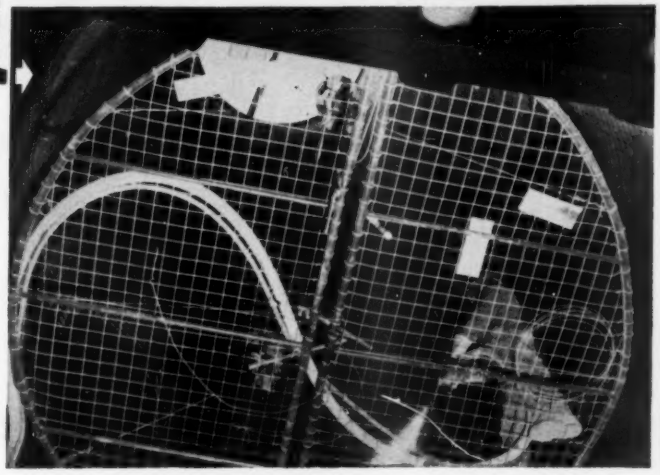


Castable Refractories

Factory-prepared mixtures of LUMNITE and selected aggregates. Mixed with water on the job, cast into place for door linings, arches, baffles, furnace walls. Special shapes can be cast in molds, ready within 24 hours. Castables to meet different temperature and insulation needs are made by manufacturers of Refractories, sold by their distributors.

Lining steel stacks with LUMNITE*

STOPS CORROSION IMPROVES DRAFTS



Looking up through working platform in stack being lined with Lumnite refractory concrete. 2½" lining is being "shot" by concrete gun over reinforcing mesh attached to angle plates welded to steel shell.

CORROSION, the No. 1 enemy of steel stacks, won't harm this one. It's getting a protective lining of refractory concrete made with Lumnite calcium-aluminate cement. The Lumnite concrete will resist corrosive attacks of condensate and sulphurous gases. In the breechings, it will withstand the abrasive action of high-velocity gases and fly ash.

Drafts will be boosted, too. Lumnite cement, mixed with insulating aggregates, keeps gas temperatures high, cuts condensation inside the stack. And because the lining is smooth and jointless, there will be less loss of draft.

Easily Installed – Maintenance Reduced

Lumnite linings may be troweled into place or "shot" on by concrete gun as shown above. Because Lumnite linings are jointless, there are no small units to work loose. Thus less maintenance is required. When repairs are necessary, they can be made quickly and cheaply, for Lumnite reaches full service strength in 24 hours or less.

Depending on requirements, Lumnite provides high structural strength, high heat resistance and low thermal conductivity. Write for descriptive booklet on Lumnite for stacks, and other refractory, insulating, corrosion-and heat-resistant concrete installations in power plants, to: Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary) 100 Park Avenue, New York 17, N. Y.

**"*LUMNITE*" *is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

PE-L-32R

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

NBC SYMPHONY SUMMER CONCERTS – *Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—June to September*

"For today and for the future..."

THEODORE E. MUELLER

President, American Radiator and Standard Sanitary Company

"For today and for the future; for yourself and for your country; the Payroll Savings Plan is a thoroughly American plan. By helping ourselves through savings we maintain and extend individual independence and help our country preserve its freedom. Thousands at American-Standard are carrying forward this sound American tradition of national-help through self-help."

". . . national-help through self-help"—that's the Payroll Savings Plan!

Introduced in 1941 and offered to millions of employees by alert managements, the Payroll Savings Plan has given employed men and women an easy, automatic way to build financial independence, save for a home, educate their children and gain many benefits that can be acquired only by thrift. It has built up a tremendous reserve of purchasing power: today, Americans hold more than $58 billion in U. S. Savings Bonds. It has helped to provide cash to retire maturing Savings Bond issues and pay off $6 billion in bankheld debt. It is one of our strongest checks on inflationary tendencies.

In these critical days, when "Defense is Everybody's Job" the Payroll Savings Plan is up front with America's defenders. Month after month, in upwards of 21,000 companies, more than 8,000,000 men and women are building a bulwark of thrift dollars. In January, 1951, 3,587,000 $25 Defense Bonds and 1,028,000 $50 Defense Bonds were purchased—the majority by serious savers on the Payroll Savings Plan.

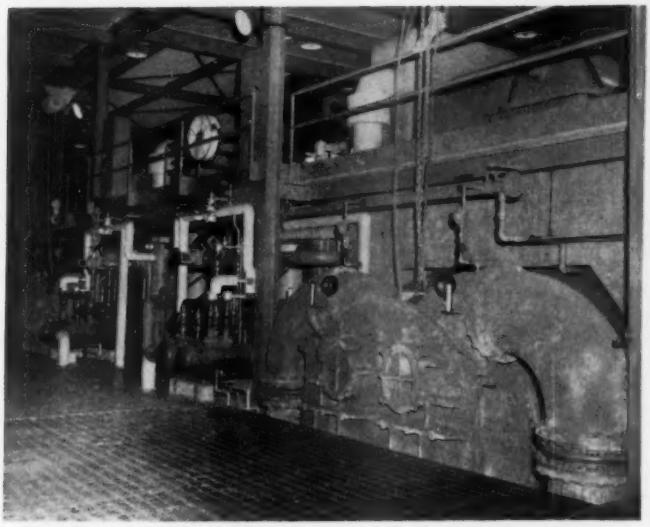
Management is doing its part—in a big way. Hundreds of companies, large and small, are reinstating the Payroll Savings Plan or vitalizing the existing plan by a person-to-person canvass that puts a Payroll Savings Application Blank in the hands of every employee. No pressure is exerted—or needed. In Mr. Mueller's American-Standard plants, for example, the person-to-person canvass added 7,800 more employees to the plan that protects.

If your company does not have a Payroll Savings Plan . . . or if you have not made a person-to-person canvass recently . . . phone, wire or write to Savings Bond Division, U. S. Treasury Department, Suite 700, Washington Building, Washington, D. C. Your State Director will be glad to help you.

The U. S. Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

Power Engineering

Undeniable Proof of



2–10,000 sq. ft. Divided Flow CONSECO Condensers installed in the Humboldt, Iowa plant of the Corn Belt Power Co-Op. Shown alongside these units are the Twin-Element 2-Stage CONSECO Air Ejectors and Single-Stage Non-Condensing Hogging Ejectors.

CONSECO

PERFORMANCE

1947 2–10,000 sq. ft. units installed and in operation

1949 1–14,000 sq. ft. unit presently being installed

1951 1–14,000 sq. ft. unit being constructed

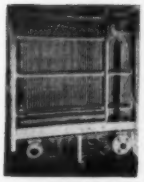
All in the Same Plant

CONSECO engineers are available at all times to meet your specific requirements in heat exchanger equipment. Their long experience and the complete fabricating facilities of Condenser Service are assurance of your obtaining maximum performance and economy. Send for illustrated engineering bulletins on CONSECO equipment.

CONSECO offers:

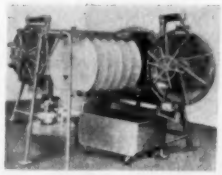
CLOSED HEATERS

DEAERATORS



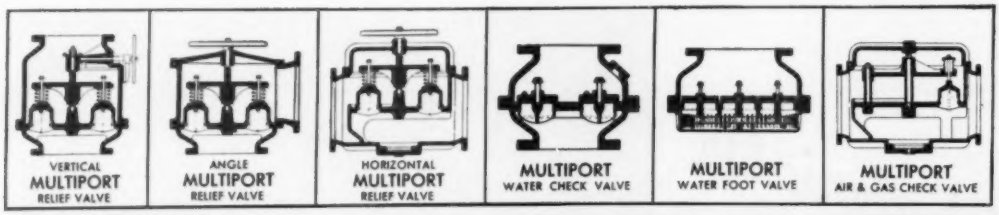
BOILERS

EVAPORATORS



REFINER FILTERS

CONSECO **Condenser Service & Engineering Co.**
HOBOKEN, N. J.


VERTICAL MULTIPORT RELIEF VALVE
ANGLE MULTIPORT RELIEF VALVE
HORIZONTAL MULTIPORT RELIEF VALVE
MULTIPORT WATER CHECK VALVE
MULTIPORT WATER FOOT VALVE
MULTIPORT AIR & GAS CHECK VALVE

THE SAFE, TIGHT, QUIET MULTIPORT RELIEF VALVE

What Owners say about Cochrane MULTIPORT VALVES

"Twenty-five years of service. No other comment."

"Opened for inspection only once in 17 years."

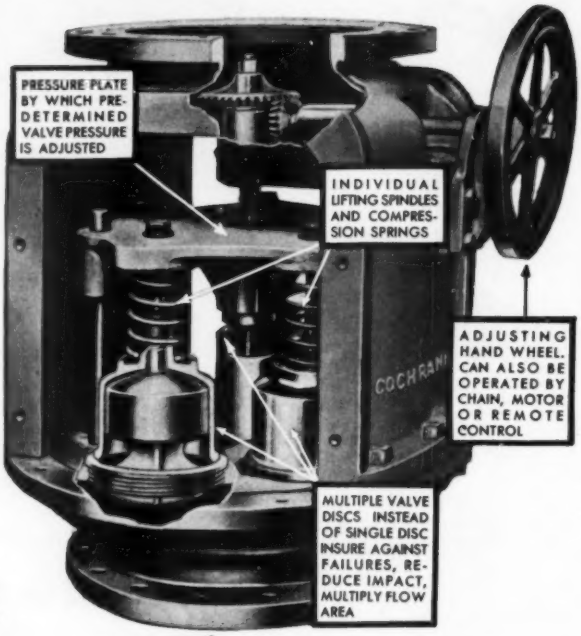
"Opening and closing every 30 seconds with but little interruption for more than 12 years."

"This valve in service about 20 years with no maintenance."

"Savings cannot be computed. Absence of trouble is worth the price."

"No maintenance except change of springs for different pressure range after almost 15 years."

"No breakdown, no trouble, no expense."


PRESSURE PLATE BY WHICH PRE-DETERMINED VALVE PRESSURE IS ADJUSTED
INDIVIDUAL LIFTING SPINDLES AND COMPRESSION SPRINGS
ADJUSTING HAND WHEEL. CAN ALSO BE OPERATED BY CHAIN, MOTOR OR REMOTE CONTROL
MULTIPLE VALVE DISCS INSTEAD OF SINGLE DISC INSURE AGAINST FAILURES, REDUCE IMPACT, MULTIPLY FLOW AREA
COCHRANE

Over 15,000 Cochrane Multiport Valves in Service
NOT ONE KNOWN FAILURE

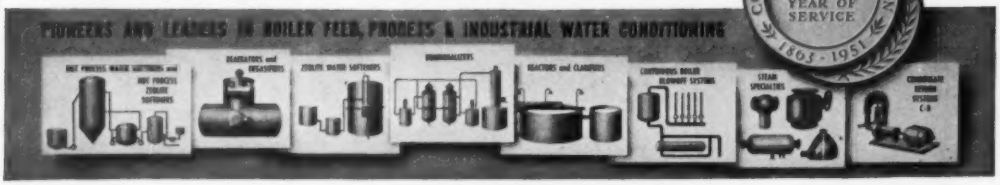
COCHRANE CORPORATION
3123 N. 17th Street PHILADELPHIA 32
In Canada: Canadian General Electric Co., Ltd., Toronto; In Mexico: Babcock & Wilcox de Mexico, S.A., Mexico City; In Europe: Recuperation Thermique & Epuration, Paris.

Cochrane Corporation
3123 N. 17th Street, Philadelphia 32, Pa.

Please send me a copy of Cochrane Publication 4150 on Cochrane Multiport Valve.

Name.....
Firm.....
Address.....
City.....Zone.....State.....

COCHRANE


PIONEERS AND LEADERS IN BOILER FEED, PROCESS & INDUSTRIAL WATER CONDITIONING
COCHRANE CORPORATION
88th
YEAR OF SERVICE
1863 - 1951

This close-up clearly shows the ribs or corrugations which add strength to Childers Jacketing and also make it form more easily around lines. Aluminum strapping and seals are a quick, inexpensive way to attach the jacketing. They can be used without any special tools and take no special training for the installers.

Does long lasting aluminum cost too much for covering your insulated lines? Not when you specify this new type weatherproof jacketing. It has been specially developed to cost little more than ordinary temporary jacketing materials.

New Low-Cost Jacketing Cuts Maintenance on Insulated Lines

AT LAST an aluminum jacket has been "engineered" especially to protect outdoor lines in refineries and chemical plants. It is the first "permanent-type" jacketing that offers both low initial cost and low application cost.

After two years of tests and major installations at 431 outdoor locations in chemical plants, refineries and power plants, the Childers Manufacturing Co. of Houston has rung up an impressive cost-cutting record with their Childers Aluminum Jacketing.

Secret behind this low cost is the thin aluminum sheet—.006" thick—which is the weather-protecting sheath of the jacketing. It is ribbed (as pictures show) for extra strength and to facilitate forming around the line. This aluminum has proved thick enough to resist weathering and usual abrasion, but costs much less than heavier aluminum sheets.

Easy application of this Childers Jacketing cuts labor bills drastically. It comes from the factory in easy-to-handle rolls that are four feet wide and either 100 feet or 200 feet long. It is light and flexible to handle as the men put it on the line. No roll forming required as with heavy, un-crimped material. It can be cut off and attached just the same as the old-fashioned tar-paper that was sometimes used for jacketing.

You can attach Childers Jacketing around your insulated lines by one of several easy methods. The use of aluminum strapping and seals is probably the best. Sheet metal screws or Minnesota Mining's No. 471 tape can also be used.

The Childers jacketing can be removed and re-used.

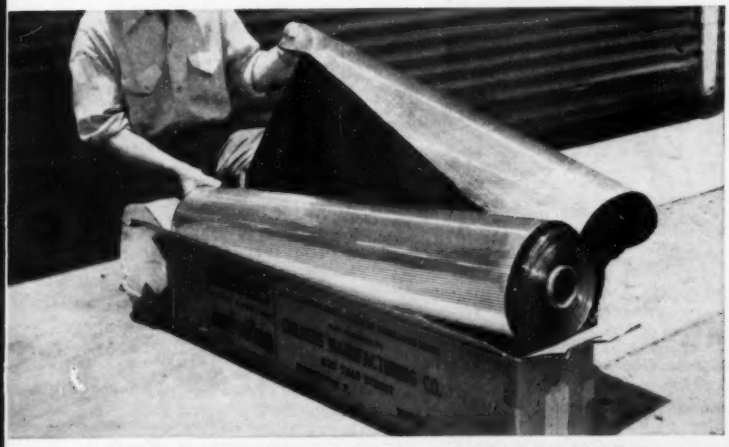
A moisture barrier is attached to the back of the jacketing to give positive protection for the aluminum when it is used with alkaline insulating materials.

No painting, no rust-proofing, little maintenance — that's the advantage of aluminum!

Hundreds of design engineers and maintenance engineers have agreed they save money for their firms and trouble for themselves by changing their jacketing specs to Childers 100%. That should make it worth your testing too—and a test roll costs only $40.00 for 400 sq. ft. (with moisture barrier attached — price for 800 sq. ft. without moisture barrier $62.00). That's a good investment in any plant. (Advt.)

* * *

FOR FULL INFORMATION write Childers Manufacturing Co., Dept. PE-1, 625 Yale St., Houston 7, Tex., for complete literature. Childers has engineering representatives in principal cities to work with you on specific problems.



This is how Childers Aluminum Jacketing is shipped in easy-to-handle rolls. It is quite flexible, yet stands up under severe weathering.

NEWS *from* THE FIELD

NEW DIRT-FALL COLLECTOR FOR USE IN AIR-POLLUTION PROBLEMS

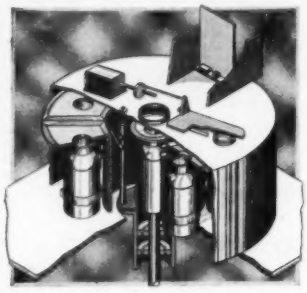
NEW INSTRUMENT for use in analyzing air-pollution problems in highly industrialized areas has been developed by Battelle Institute, Columbus, Ohio. Because it will tell the direction from which large quantities of dirt come, it is expected it will be useful to industries and municipalities in locating the sources of air-pollution nuisance.

Known as a "directional dirt-fall collector", the new instrument will provide an index of the general location of plants which may be responsible for heavy dirt fall. It will evaluate, in a city such as New York, for example, the amounts of dirt blown from across surrounding rivers as well as the amounts of dirt originating directly from Manhattan locations.

The dirt-fall collector, which will be made commercially available by Eberbach & Son Co., Ann Arbor, Michigan, is designed to collect heavy dirt from any direction the wind is blowing (see drawing for detailed description). For a reliable indication of the sources of heavy contamination the instrument must be exposed for 30-day collection periods over many months in a carefully chosen location representative of a given area.

Amounts of collected material must be correlated with data obtained from the Weather Bureau. A so-called "wind-rose pattern" shows the number of hours the wind has blown from the eight points of the compass. Knowing this, it is then possible to determine the relative amounts of dirt which have fallen per hour into the instrument from the various directions.

For a complete dirt-fall collection program, several directional dirt-fall collectors are required. Simultaneously, fine particles (aerosols) and gas and odor concentrations in the air, along with weather conditions, may be analyzed using other appropriate instruments and equipment.



Directional dirt-fall collector consists of a series of eight jars arranged in a circle with a ninth jar in the center. These jars have metal funnels which will collect the dirt not falling directly into the jar mouth. At the end of the collection period, the dirt may be brushed into the appropriate jar

Jars are covered by a canopy which has one hole at the outside edge and another at the center. When the wind is blowing at a velocity greater than 3 miles per hour, the outer hole is uncovered and the wind vane turns the canopy in such a way that the dirt is collected in the jar corresponding to one of the wind directions on the eight points of the compass. When the wind falls below 3 miles per hour, the auxiliary wind vane (which is perpendicular to the directional wind vanes) moves to a vertical position closing an electrical contact which operates the motor to move the cover closing the outer hole. In this same operation, the inner hole is uncovered and all of the dirt falling during this period of calm is collected in the central jar. When the wind velocity exceeds 3 miles per hour, the auxiliary wind vane is blown from a vertical position and an electrical contact moves the cover to close the center hole and uncover the outerhole.

JESS HARRISON DAVIS NAMED PRESIDENT OF STEVENS

DR. JESS HARRISON DAVIS, 44, president of Clarkson College of Technology, Potsdam, N. Y., has been elected to succeed Dr. Harvey Nathaniel Davis, 70, (no relation) as president of Stevens Institute of Technology, Hoboken, N. J. The new president is the fourth in the 81-yr history of the college and will assume his duties September 1, 1951.

The new president has had a varied and distinguished career as an en-

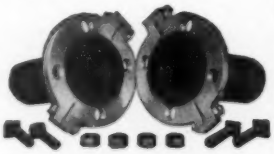
GOODALL
EXPANSION JOINTS
Right-Angle or
"FLANG-LOK"

For All Standard
Iron Pipe Sizes
From ⅜" to 96" I.D.

In both Right-Angle and "Flang-Lok" styles, Goodall Expansion Joints are built with the exacting care that assures the utmost in durability, efficiency and safety under all service conditions. Long experience guides the selection of materials from which they are made; and craftsmen specialists apply unequalled skill to every detail of construction. Used under pressure, vacuum or both, they will stand repeated flexing, with maximum resistance to cracking and "setting."

Advantages of "Flang-Lok"

The combination of "Flang-Lok" End Expansion Joints and "Flang-Lok" Floating Flanges assures quick, easy installation even in extremely "close quarters." It is only necessary to turn the flange (not joint or pipe) to align bolt holes with connecting flange. As flange bolts are tightened, rubber end of joint is compressed over a broad area of connecting flange, providing a leak-proof seal having the widest margin of safety against rated pressures.



"Flang-Lok" Flanges are of cast iron or steel, and drilled to conform to A. S. A. drilling templates in 1" and larger. They are split type, with segments readily bolted together over end of joint, in preparation for actual connection. Design covered by U. S. Pat. No. 1883086.

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Est. 1870

gineering educator and industrial consultant. He was graduated from Ohio State with a degree in science in 1928 and received his master's degree there in 1933. In 1949 he received the degree of doctor of science from St. Lawrence University.

His industrial career has included service with Ohio Bell Telephone Co., Alabama Power Co., American Locomotive Co., and Foster Wheeler Corp. He has served as consulting engineer for Hydraulic Controls, Inc., New York Air Brake Co., D. M. McBean, and De Wolf Furnace Corp. He is presently on the board of directors of the Niagara Mohawk Power Corp.

The new president of Stevens is a licensed engineer in New York and Kentucky. His professional societies include ASME, the Engineering College Administrative Council, ASEE, and the Kentucky SPE.

DETROIT EDISON ANNOUNCES NEW PLANT VIA ALL-COMPANY TV MEETING

A BRAND-NEW television and employe relations field was opened last night when Detroit Edison employes and their families throughout southeast Michigan attended — via TV — an "all company meeting."

The meeting, believed to be a television "first," featured a film-illustrated report on the Company's activities to its nearly 12,000 employes. The report was highlighted by announcement of plans for a new Edison power plant, and a proposed interconnection for exchange of power with the Ontario electric system, provided government approvals can be secured.

The program featured a Company progress report by Edison President James W. Parker, and a discussion of generating facilities by George A. Porter, chief engineer of power plants.

Announcing plans for the new power plant — the sixth major steam-electric plant for the Company — Parker said it would be located on the Detroit River front near the mouth of the Rouge River. He said the plant would help serve future added loads in that area and would make more power available throughout the Company's 7,500-square-mile service area.

The new generating station will be named the River Rouge Edison Plant. A date for starting construction has not been set. The project is part of a long-range expansion program that will bring Edison's generating capability to more than 3,000,000 hp by late 1953.

Commenting on proposed interconnections for electric power exchange with Ontario Hydro, Parker said studies were under way which were expected to result in two transmission ties, one crossing the Detroit River, and the other crossing the St. Clair River.

Speaking of special problems faced by the electric industry in times of indefinite emergency like the

You can't beat a DART for a snug drop-tight fit!

Why? The answer is easy! It's because Darts are made with greater care.

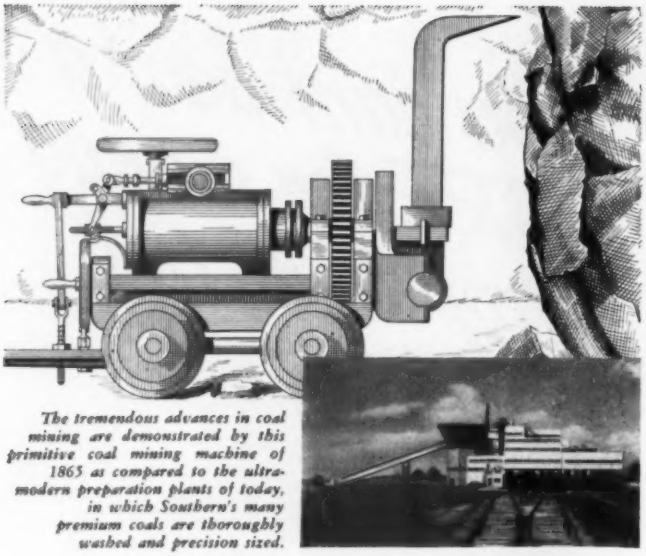
Take the joint, for instance! Both seats are made of resistant bronze; both are swaged into place under great pressure — permanently interlocked with the ends. And both are precision machined, then carefully spherically ground to give very wide, near perfect contact.

Finally — to protect the seats, give extra strength — ends and nut are made of *practically indestructible,* air-refined, high test malleable iron.

Little wonder Darts are drop-tight without excessive wrenching. No wonder you can use them again and again.

DART UNION COMPANY
Providence 5, Rhode Island
The Fairbanks Co. — Distributors
Boston New York Pittsburgh

DART UNIONS



The tremendous advances in coal mining are demonstrated by this primitive coal mining machine of 1865 as compared to the ultra-modern preparation plants of today, in which Southern's many premium coals are thoroughly washed and precision sized.

Here's why SOUTHERN'S Wide selection of premium, washed coals can help you reduce steam costs

Basic requirement for most economical steam production is to make certain that the *right* coal is applied to your specific type of burning equipment. SOUTHERN'S service to industry fulfills this requirement two important ways:

1. The industry's widest selection of scientifically prepared premium coals from the leading eastern and midwestern fields and seams.
2. A staff of trained combustion engineers—ready to consult with you on which *one* of SOUTHERN'S many coals can effect greatest savings in your plant.

SOUTHERN'S approach to all types of coal purchasing and burning problems is factual—including plant surveys and actual burning tests.

Add to this, SOUTHERN'S dependable supply...big production in excess of 10,000,000 tons annually from the most modern mines in existence...plus vast reserves.

Get the full details about how SOUTHERN'S service is lowering costs in hundreds of America's leading steam producing plants. Call, wire or write our nearest branch office today.

AS MANY AS 25 PREMIUM COALS

SOUTHERN offers industrial buyers a wide variety of premium coals from the coal fields of Western Kentucky, West Virginia, Virginia, Eastern Kentucky, Illinois, Indiana, Alabama, Arkansas, and Oklahoma. *One is right for your plant!*

A TESTED COAL TO MEET EVERY INDUSTRIAL REQUIREMENT

Skibo Coke · Illinois Coal · Seminole Coal · Vogue Coke · Old Ben Coal · Sunlight Coal

Southern Coal Company, Inc.

General Office: 333 North Michigan Avenue, Chicago 1, Ill.
Offices in: ATLANTA, BIRMINGHAM, CHICAGO, GREENVILLE, KNOXVILLE, LOUISVILLE, MEMPHIS, NASHVILLE, ST. LOUIS
Sinclair Coal Company, Kansas City 6, Mo.—Western Representative
Boon-Strachan Coal Company, Ltd., Montreal—Canadian Representative

present, Parker emphasized the need for "a wisely-conceived, Congressionally-enacted national power policy."

"This would help industry and government work together on the continuing job of furnishing the nation's light and power," he said, "and it would assure America of maintaining its top position among the power producing countries of the world."

Parker said the electric companies do not oppose essential regulation and controls. "They welcome them," he said. "What they do oppose is the vagueness of the present national power policy, and the fact that it is not generally based on decisions by those who should make them — the people's representatives in Congress."

Employes were commended for their excellent safety record, kept up despite the hazardousness of many of their jobs. Edison overhead linemen recently won a national award for putting in 1,000,000 hrs of work without a single disabling injury. Underground linemen, exposed to traffic and other hazards, are maintaining a similarly high safety record, it was reported.

TWO MORE 150,000-KW UNITS FOR CHICAGO AREA

NEW GENERATING STATION in Will County on the banks of the Chicago Sanitary and Ship Canal between Lockport and Lemont, Ill., is being planned by Public Service Co. of Northern Ill. A site has been purchased and preliminary plans and surveys for location of station building, barge docks, coal storage yard, electric switchyard and other facilities are being made. The first two generating units, with capacities of 150,000 kw each, have been ordered. It is expected that the station will be completed and the new units in service by the fall of 1954.

The Will County station site is adequate for development of a 1,000,000-kw plant, more than 3 times the initial capacity to be installed, and it will be designed to provide for additional generating units. The property is served by the Elgin, Joliet & Eastern Railway, which has connections with all major Chicago area trunk lines and by the Illinois Waterway over which coal can be barged direct to the site.

The new station will be 12th in the interconnected power system serving Chicago and Northern Illinois.

COAL-BURNING GAS TURBINE OFFICE MOVES TO DUNKIRK, N.Y.

THE RESEARCH OFFICE of The Locomotive Development Committee of Bituminous Coal Research, Inc. has been moved from 10 Light Street, Baltimore, Md., to 320 So. Roberts Road, P. O. Box 225, Dunkirk, N. Y.

This committee is working on the development of a coal-burning gas turbine, to be first applied in a railroad locomotive. For some time, the

committee has had a testing laboratory in the plant of American Locomotive Co. at Dunkirk, where full scale tests of coal preparation and burning equipment, ash removal equipment and other auxiliaries have been under way. In this laboratory, a Houdry gas turbine has already been operated for 1000 hr burning pulverized coal and now a full-size locomotive gas turbine is being set up for test. This experimental laboratory has been directly supervised by Fred D. Buckley.

A detailed account of the recent encouraging progress in developing the coal-burning gas turbine is given elsewhere in this issue by John I. Yellott, Director of Research of The Locomotive Development Committee. Peter R. Broadley is assistant director of research.

ALLIS-CHALMERS TO BUILD AIRCRAFT COMPRESSORS

LARGEST subcontract yet signed in the Curtis-Wright Corp. defense expansion program has been announced — a multimillion dollar order to Allis-Chalmers Manufacturing Co. for the Wright J65 Sapphire turbo jet aircraft engine.

Allis-Chalmers will shortly begin construction of a new plant for the manufacture of compressors for the Wright Sapphire, an engine of 7200 lb thrust, which powers the Republic F84F thunder jet fighter. The Sapphire is one of the most powerful jet engines in production anywhere in the world.

Wright Aeronautical Corp.'s engine division of Curtis-Wright is currently entering a large scale production of the Sapphire at its plant in Woodridge, New Jersey.

W. A. Roberts, president of Allis-Chalmers, announced that this new contract requires the building of a new plant to cost in excess of $5,000,000.

* * *

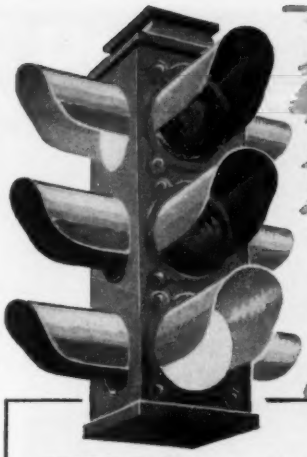
THE CHICAGO midwest headquarters for Sarco sales representatives moved on April 30, 1951 to new and larger space at 322 West Randolph St., Chicago 6, Illinois. The new telephone number is Andover 3-2513-4-5.

* * *

ONE OF the nation's leading atomic scientists, Dr. Charles Allen Thomas, has been elected president of Monsanto Chemical Co.

Dr. Thomas, who was prominently identified with the production of the atomic bomb and co-author of a plan for control of nuclear weapons, took office May 1. The 51-year-old scientist replaces William M. Rand, who retires under the company pension plan.

Dr. Thomas, who has been Monsanto's executive vice president since 1947, began his industrial career with General Motors, aiding in the development of ethyl gasoline and later established research laboratories

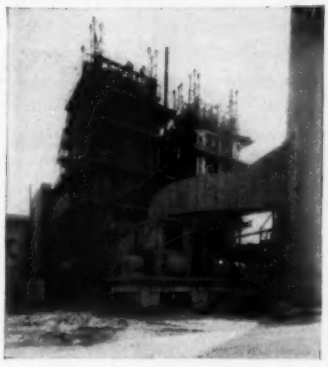


DRAFT FANS GO on GREEN

GREEN FANS . . . Used by Many Leading Utilities

One significant fact about Green Fan Installations at the New Orleans Public Service Plant is that two different boiler manufacturers were involved . . . two different types of boilers but Green Draft Fans for all three boilers. Each boiler has two Green Induced Draft Fans and one Green Forced Draft Fan.

When a concern has specialized on an important piece of power plant equipment for many years, that firm is rightly called the "authority" on the subject. This is the position of Green Fuel Economizer Co. in the field of mechanical draft fans. The name Green is synonymous with Draft Fans highly acceptable to industry.



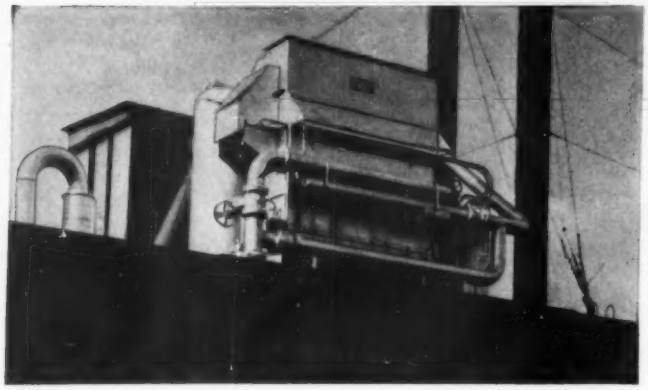
The Line of Green Induced and Forced Draft Fans includes many types in many sizes which are described in Bulletin No. 168. We shall be glad to discuss your fan requirements with your own engineers, with your consulting engineers and with the boiler manufacturer of your choice.

THE GREEN Fuel Economizer COMPANY INC.

BEACON 3, NEW YORK

ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

Direct saving of cooling water expense returns to you the cost of a Niagara Aero After Cooler in less than two years.



How to Get Drier Compressed Air:

It prevents many troubles and saves much expense

● NIAGARA AERO AFTER COOLER cools compressed air or gas below the temperature of the surrounding atmosphere. Therefore you get no further condensation in your lines. You save much in repairs to pneumatic tools and equipment; you save much interruption to production; you save water damage in paint spraying, in air cleaning, in any process where compressed air comes in contact with your materials or parts in manufacturing (sand blasting, for example).

Niagara Aero After Cooler uses evaporative cooling, saving 95% of your cooling water consumption. This saving quickly returns the cost of the equipment to the owner or makes extra cooling water available for other processes.

The Niagara Aero After Cooler produces compressed air with 30% to 50% less moisture than by ordinary cooling methods. Other Niagara equipment provides bone-dry air for processes requiring it.

If you have an air problem or a cooling problem, a Niagara engineer probably has an answer that will improve your process or save you operating or maintenance expense.

Write for Bulletin 98

NIAGARA BLOWER COMPANY

Over 35 Years Service in Industrial Air Engineering

Dept. E, 405 Lexington Ave. **New York 17, N. Y.**

Experienced District Engineers in all Principal Cities

in Dayton, Ohio. The laboratories were acquired by Monsanto in 1936 and Dr. Thomas became the company's research director. He then moved up through successive positions to the presidency.

* * *

JOHN C. WALLACE, formerly special projects development engineer with Baldwin-Lima-Hamilton Corp., has been appointed chief engineer for the newly created diesel engine parts research and development division of Hunt-Spiller Manufacturing Corp., A. J. Edgar, vice president and general manager, announced.

* * *

THOMAS C. WILSON, INC., will open a new office at 3147 North Broad Street, Philadelphia 32, on June 1st. This new Wilson headquarters will serve the Philadelphia, Camden and Trenton areas.

Mr. Henry Steffans, who has been a Sales Engineer for Wilson in New York since 1949, has been appointed Manager of the new Philadelphia office.

* * *

THE DAMPNEY CO. announces the promotion of Lachlan W. MacLean to the newly created position of Vice-President in Charge of Manufacturing and Engineering. The company announces simultaneously the appointment to its Boston Sales Office staff of John D. MacDougall. Mr. MacDougall received his A.B. degree from Boston College in 1951.

* * *

BATTELLE INSTITUTE, Columbus, Ohio, has begun construction on the new million-dollar laboratory building.

The new laboratory, according to Battelle Director Clyde Williams, results from increased demands for research services in behalf of the nation's defense effort. The construc-

tion has been approved by the National Production Authority as a result of endorsement by military and other governmental agencies.

The new construction will be Battelle's fifth in the past decade. A three-story structure with two bays for pilot plant operations, the new building will provide approximately 80,000 sq ft of work area and will house 115 unit laboratories.

Currently, Battelle's research volume surpasses $8,000,000 annually and includes important defense studies for the Atomic Energy Commission, the Army, Navy, and Air Force. It is expected that the new building will allow a 15 to 20 per cent increase in Battelle research services.

Obituaries

OSBORN MONNETT

OSBORN MONNETT, for 40 yrs a consulting engineer in Chicago, associated principally with Commercial Testing and Engineering Co., died on May 13 at his home in Lakeside, Ohio. He was 74 yrs old.

Mr. Monnett began his career as a marine engineer on the Great Lakes and then served as superintendent of power in large railroad shops of W.L.E. and C.R.I. & P. railroads. For a time he was assistant editor of *The Engineer* in Chicago, the editor being A. L. Rice, afterwards editor *The Practical Engineer* and *Power Plant Engineering*, both predecessors of POWER ENGINEERING. Later Mr. Monnett was associate editor of *Power* in New York, then Western editor of *Power* in Chicago.

Osborn Monnett

Subsequently he served for 4 yrs as chief smoke inspector for the City of Chicago and in that capacity prepared a smoke ordinance that became a basis for legislation in several large cities. He then became research engineer for American Radiator Co. and advisory engineer of the staff of the Conservation Bureau, U. S. Fuel Administration.

He specialized in combustion and boiler practice and for many years was associated with Commercial Testing and Engineering Co. in Chicago and with its power plant consulting engineering division, Carroll, Bechtel and Langtry. He also had connections with Orrok, Myers & Shoudy of New York.

He was consulting fuel engineer to

Damper Regulators

Sensitive—Hydraulic—Automatic

ATLAS

TRADE MARK REG.

WHAT THEY DO

1 — ATLAS Damper Regulators continuously maintain the desired pressure in steam boilers by automatically adjusting the boiler drafts or dampers.
2 — On forced draft boilers they may be arranged to control the speed of the fan.
3 — From the fan they may then be made to indirectly regulate the rate of feed of stokers on stoker fired boilers.
4 — By regulating the draft they reduce the amount of air used to the desired minimum, air inleakage through boiler settings being simultaneously minimized.
5 — It is plain that with air volume minimized a higher and more efficient furnace temperature is attained and maintained. The modern engineering trend is toward higher furnace temperatures. Radiant heat varies as the "fourth power" of temperature. ATLAS regulation causes a vast increase in radiant heat.
6 — CO_2 is kept where it should be and CO is avoided.
7 — Much fuel is saved by reducing the volume of air used, eliminating CO, and keeping the chimney gas temperature down where it belongs.
8 — ATLAS Damper Regulators save labor. Without an ATLAS it is necessary to regulate boilers "by hand." Hand regulation is far inferior to ATLAS automatic regulation. Hand regulation costs much more for labor and, even when watched CONSTANTLY, gives a lower boiler efficiency than ATLAS control.
9 — In view of the above it is clear why ATLAS Damper Regulators quickly pay for themselves. Installed on almost any boiler, they are an important economy factor.

The Damper Regulator shown at the right is No. 502. For boiler pressures up to 150 pounds. Will move damper on boiler pressure changes of ¼ pound.

Ask for Bulletin 4-A which Tells All

Bulletin 4-A explains in full why ATLAS Damper Regulators are so valuable on boilers of nearly every size and type. You can get a copy by using the coupon at the right. Also, note the other ATLAS products listed in the coupon.

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☐ Please send Bulletin No. 4-A on ATLAS Damper Regulators. Also, please send information on the following ATLAS Products.

☐ CAMPBELL Boiler Feed Regulator	☐ Pump Governors
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☐ Pressure Regulators	☐ Thermostats
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	☐ Oil Control Cocks

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REGULATING VALVES FOR EVERY SERVICE

Specialists in Regulation for Over a Half Century

293 South Street • Newark 5, New Jersey

REPRESENTED IN PRINCIPAL CITIES

Spotlighting DEPENDABILITY in the RICHARDSON coal scale

Another reason why thousands of power installations keep an accurate check on boiler efficiency with Richardson Automatic Coal Scales.

A basic design feature of Richardson Automatic Coal Scales, the standard 20" x 20" inlet opening has been proved right for the job . . . on the job. Extensive laboratory test runs and the experience of field operation proved to Richardson engineers that an inlet of this size assures positive flow of coal at all times, wet or dry, with never a "hang-up." A flexible inlet connection on all Richardson Automatic Coal Scales also accommodates bunker "breathing" movement and greatly facilitates installation.

Some of the other features that make Richardson Scales the standard of comparison throughout industry are:

QUICK-RELEASE BY-PASS MECHANISM for emergency re-routing coal direct to stoker or pulverizer.

HINGED LEVELING PLATE to establish a uniform "breakaway" of coal each time the feeder belt is stopped, and to allow passage of occasional large lumps without damage to belt.

ALL ELECTRICAL EQUIPMENT mounted outside of corrosive atmosphere of coal chamber.

BELT-FEEDER SKIRT-PLATES sloped inward to decrease belt load and power consumption, increase belt life.

3 BULLETINS AVAILABLE

Send For Them Today For Complete Information On: EE-39, for dust-tight average service—200-300 lbs. per discharge—**Bulletin No. 0150.**

Model K-39, for pressure-tight (up to 60" of water), large-capacity service—400-500 lbs. per discharge—**Bulletin No. 0250.**

Monorate, non-segregating coal distributor—**Bulletin No. 1349.**

Richardson

MATERIALS HANDLING BY WEIGHT SINCE 1902

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RICHARDSON SCALE COMPANY
Clifton, New Jersey
Atlanta • Boston
Buffalo • Chicago • Cincinnati
Detroit • Houston • Minneapolis
New York • Omaha • Philadelphia
Pittsburgh • San Francisco • Wichita
Montreal • Toronto

the U. S. Bureau of Mines on atmospheric survey of Salt Lake City and was first to use airplanes in this type of work. He was the author of many technical papers and treatises on boiler furnace design for smokeless operation, establishing standards of practice adopted in Chicago and elsewhere. He was director of smoke survey of Memphis, Tenn., and consulting engineer to the City of St. Louis and its smoke abatement league.

Mr. Monnett leaves his widow, Lena, and three daughters, Mrs. Genevieve Hasenmiller of Milwaukee, Mrs. Mildred Eberle of Lakeside, and Mrs. Phillip Weideman of Pasadena, Calif.

WARD S. PATTERSON

WARD S. PATTERSON, executive assistant to the vice president in charge of engineering, Combustion Engineering-Superheater, Inc., New York, died at the Northern Westchester Hospital, Mt. Kisco, New York, on May 21.

Born in Rangeley, Maine, November 3, 1904, Mr. Patterson studied engineering at Cornell University, graduating in 1926 with the M. E. degree. He was a member of Tau Beta Pi — an honorary engineering fraternity.

Joining Combustion Engineering immediately upon graduation, he served in various capacities, later heading up the calculating engineering group and more recently becoming executive assistant to the vice president in charge of engineering. Here he was charged with research and development responsibilities, particularly in connection with controlled circulation for boilers, in which he was a specialist.

Widely known in engineering circles, both here and abroad, Mr. Patterson had been an active member of the American Society of Mechanical Engineers for the past 25 years, taking part in much committee work and as the author of numerous technical papers. Last summer he delivered an outstanding paper before the World Power Conference in London. Also, he held many patents in the field of boiler design.

He was a resident of Chappaqua, New York; survivors are his wife and two children.

JAMES M. KENNY

JAMES M. KENNY, a contract engineer for Combustion Engineering-Superheater, Inc., died on May 12 at the age of 48. A native of New York City and a graduate of St. Francis College and Brooklyn Polytechnic Institute, Mr. Kenny joined the Drafting Department of Combustion in 1936 and transferred to the Engineering Department in 1941. Most of his work was in connection with the design and application of VU steam generating units. He is survived by a daughter and two sons.

HELPFUL BULLETINS

(*Continued from page 38*)

that model under his own raw water conditions. Penfield Mfg. Co., Inc.

129 **Large Volume Filtration** — Six-pp Bulletin 12505M describes and pictures a self-cleaning filter which requires little floor space yet provides big capacity, and is economical to operate. Tells how filter is built, how it works. Discusses municipal, industrial, commercial applications; gives specifications. Sparkler Mfg. Co.

LUBRICANTS

130 **Dehydration Systems** — This 4-pp bulletin presents pressure type and gravity type dehydration systems for cleaning, stabilizing, and degasifying lubricating oils. Explains their features, sequence of operation. Illustrated; includes specifications, dimensions and weights. Bowser, Inc.

131 **Molybdenum Disulfide** — Available to power engineers interested in molybdenum disulfide as a lubricant is this 60-pp booklet of excerpts from technical papers. They cover such subjects as friction of solid films on steel at high sliding velocities, oxidation characteristics of molybdenum disulfide, effectiveness as a fretting-corrosion inhibitor, also friction properties of various lubricants at high pressures. Climax Molybdenum Co.

OIL BURNERS AND ACCESSORIES

132 **Oil Burning System** — Bulletin 109-B, 4 pp, describing a constant differential pump system for use on oil combustion installations, explains what this wide range system is designed to do, and discusses and illustrates principle of control. An actual steam flow chart from one of the boilers at a large steam station is pictured, as are some installations of this pump system. Peabody Engineering Corp.

133 **Flexible Connections** — High temperature, ball bearing swivel fittings for flexible connections for oil burners are described in this 4-pp bulletin. Explains their design, construction, packing used. Includes dimensions, prices and instructions for installing, operating and maintenance. Rasmussen Mfg. Co.

MAINTENANCE

134 **Chemical Cleaning Service** — Reduced maintenance costs and outage time are among advantages of company's chemical cleaning service for steam equipment and water lines discussed in this 8-pp bulletin. Before-and-after photos show some actual cleaning jobs and several case histories are given. Company's service procedure and facilities are outlined. Dowell Inc.

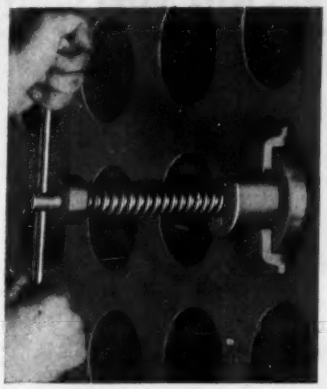
135 **Water Tamer** — This small 12-pp folder describes Immunol, an industrial solvent for "taming" water — making it rustproof. Efficiency and economy of the solvent are discussed, also its non-inflammability and other safety features. Specific applications are described. Haas Miller Corp.

PACKING, GASKETS

136 **Packing Rings** — Manufacturer's Vee-Flex packing rings are featured in this 4-pp bulletin. These rings are for use in valves, pumps, hydraulic cylinders, and bulletin discusses conclusions of company engineers from tests performed at outside laboratories. Dimensions, service recommendations included. Packing Div., Raybestos-Manhattan, Inc.

137 **Industrial Gaskets** — This recently-published 50-pp catalog covers an extensive line of gaskets and teflon products, including practically all types of metal, metal-asbestos and special gaskets as well as teflon packing and expansion joints and teflon stock. Includes both engineering and ordering data, application and installa-

48 man-hour job done in only 4 hours with a ROTO Hand-hole Seat Scraper



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

If you operate any of the boilers listed below, you can't afford to be without a ROTO Hand-hole Seat Scraper.

A Pennsylvania manufacturer reports that it formerly took three men 2 to 3 days to clean inside cap seats on a Keeler Boiler header. Now, with a ROTO Hand-hole Seat Scraper, one man does it in four hours, besides doing a better job.

This simple, hand-operated tool is equipped with retractable knives mounted on the end of a revolving spindle having a bearing in a substantial yoke. An adjustable spring automatically maintains tension on the knives, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right, and the job is done. A half turn to the left releases the tool. Write for bulletin and prices.

MAKE OF BOILER	TUBE SIZE	OPENING
Babcock & Wilcox	4"	Oval
B. & W. No. 40 Header	3¼"	Oval
B. & W. No. 41 Header	2"	Oval
B. & W. Superheater	2"	Round
Babcock & Wilcox	4⅜ x 5"	Square
Casey Hedges	4"	Oval
Casey Hedges	3½"	Oval
Combustion Engineering	3"	Round
Edge Moore	4"	Oval
Franklin	4"	Round
Geary	4"	Oval
Heine	3½"	Oval
Heine	3½"	Round
Keeler	4"	Round
Keeler	4"	Diamond
Murray	4"	Oval
Murray	3½"	Oval
Oil City	4"	Oval
Oil City	3½"	Oval
Union Iron Works	4"	Pear Shape
Walsh & Widener	4"	Oval

Roto Hand-hole Seat Scraper for Heine Boiler.

ELLIOTT COMPANY-ROTO DIVISION

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Paracoil EVAPORATORS

for STATION HEAT BALANCE or FRESH WATER SUPPLY

Shop View of SALT AND FRESH WATER EVAPORATORS built by PARACOIL for San Juan Steam Electric Station, Porto Rico Water Resources Authority, San Juan, Porto Rico. Jackson & Moreland, Boston, Mass., Consulting Engineers

HERE'S A JOB WE'VE BUILT FOR SAN JUAN, P. R.

Wherever pure water is needed for boiler feed makeup, process work or general plant operation, a PARACOIL EVAPORATOR is a proven, time-tested means of handling any kind of initial raw water—salt or otherwise.

They are ruggedly built—dependable—and easily maintained. Specific requirements dictate the design. Our years of experience in building units of this type—and other power plant apparatus—assures you of the correct solution to your problem. *We invite your inquiry.*

DAVIS ENGINEERING CORPORATION
1062 East Grand Street, Elizabeth 4, New Jersey
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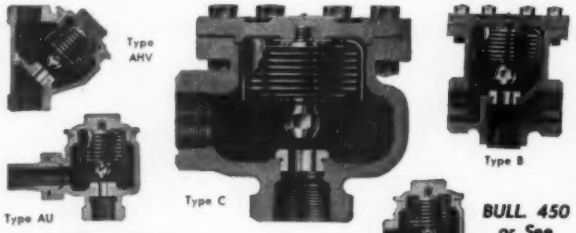
In This Plant Nicholson Traps

SAVED 10% IN STEAM COSTS

Chief Engineer H. F. D. stated, after Nicholsons replaced mechanical traps in his plant: "Saving in steam waste cut our fuel cost at least 10%. Yet application temperatures were up 30°–40°. And relief of all air binding effected faster warm-up."

Operate on lowest temperature differential; 2 to 6 times average drainage capacity; maximum air venting. For other advanced Nicholson features send for Bulletin 450.



5 TYPES FOR EVERY APPLICATION, process, heat, power. Sizes, ¼" to 2"; pressure to 225 lbs.

BULL. 450 or See Sweet's

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Sales and Engineering Offices in 57 Principal Cities

tion suggestions. Generously illustrated with photos and drawings, also provides temperature conversion and steam tables, other helpful tabular matter. United States Gasket Co.

INDUSTRIAL FILMS

138 **1951 Film Guide** — Seventy-two sound films covering general interest subjects, product information and training and instruction are listed in Catalog B-4761, company's new 76-pp listing. Divided into sections for easy reference, catalog describes each film, tells the people it should interest, the film size, projection time, shipping weight etc. Typical films are, "Electrical Proving Ground," and "Hints on Electrical Servicing in the Air-Conditioning Industry." Basic rules of operation, ordering information included. Films listed are loaned free to organized groups; borrower pays cost of transportation. Westinghouse Electric Corp.

139 **Principles of Automatic Control** — The 55 min., 16 mm sound film described in this leaflet should be helpful in presenting the subject of automatic control to technical personnel, instrument mechanics, production supervisors. Details on how film can be obtained for showing by engineering groups and schools or purchased by companies for their own training programs are given. The Instrument Society of America.

OTHER EQUIPMENT

140 **Blowers and Exhausters** — Operating characteristics and design and construction features of both single-stage and multi-stage units are covered in 24-pp Bulletin 120-B-14 on manufacturer's line of centrifugal blowers and exhausters. Fully illustrated with photos, sectional drawings. Includes chapter on manual and automatic controls. Roots-Connersville Blower Corp.

141 **How to Save Waste Heat** — The utilization of unit heaters for recovery and distribution of waste heat from engine and compressor jacket water is covered in 4-pp Form 00531A. Method of using waste heat to lower space heating costs is explained. Several installations are detailed to illustrate piping hookups, control methods. Also shows how to select correct size and type of heater. Modine Mfg. Co.

142 **Block Insulation** — This 4-pp folder tells economic advantages of company's Superex, listing outstanding properties of this high temperature block insulation. Includes conductivity and heat loss graphs and a recommended thickness table. Some of the special shapes in which this insulation can be furnished are pictured. Johns-Manville.

143 **Viscosity Packet** — To give power engineers as complete information as possible on company's viscometers and the general subject of viscosity this file of literature is offered. Includes an 8-pp catalog, data sheet, current price lists, "what users say" brochure and list of article reprints available from company files. Brookfield Engineering Laboratories, Inc.

144 **Equipment for Air Conditioning** — Everything needed to do a job of air conditioning — cooling, heating, dehumidifying, cleaning, filtering, circulating; or ventilating or air handling — is covered in 16-pp Catalog SA-6692. Equipment listed is selected from manufacturer's full line. Includes selection data on hermetically sealed compressors, condensers, water coolers, heating and cooling coils, air handling units, dehumidifiers, washers, self-contained units, heaters, fans and inlet vane control assemblies. Sturtevant Div., Westinghouse Electric Corp.

145 **Design Data on Thread Inserts** — Bulletin 650-R, 16 pp, covers design data on helical-wire thread inserts and their use in the protection and repair of tapped holes. Detail drawings and text explain how inserts protect tapped threads in aluminum, magnesium, plastics, iron, steel and wood against stripping, wear, corrosion, seizing and galling. Also covered are their uses in

production salvage operations, in maintenance and repair work. Tabular data includes basic insert lengths, recommended drill sizes, roughing and finishing-tap specifications and gages to be used when installing various sizes and types of inserts. Heli-Coil Corp.

146 Straight Chromium Stainless Steel — Restrictions on use of nickel in steel have forced investigation into the use of straight chromium stainless grades. Bulletin TDC, 140, 4 pp, outlines physical and mechanical characteristics of three non-hardening straight chromium stainless tubing steels. Includes technical data on analyses, creep strength, properties at room and elevated temperatures, corrosion and oxidation resistance, forging, forming, machining, welding. The Babcock & Wilcox Tube Co.

CATALOG LIBRARY

(*Continued from page 50*)

WATER CONDITIONING

244 Water Conditioning Information — Here are three informational bulletins of value to power engineers. No. 28X7446 describes a simple and accurate way to determine total hardness in water, illustrating procedure and explaining principle. No. 28X7559 gives an analysis of the hot process-hot zeolite system, telling results to be expected and advantages. No. 28X7466 discusses current status of embrittlement in boilers, explaining causes and telling recent developments in control methods. List bulletins wanted. Allis-Chalmers Mfg. Co.

245 Modern pH and Chlorine Control — This 100-pp booklet gives technical details of company's color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

246 Water Softeners — Bulletin WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, explains chemistry of hot-process water softening. Graver Water Conditioning Co.

247 One-Minute Water Tests — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50, 4 pp. Procedures, reagents, and equipment are pictured and described. Bulletin tells how tests may be used to determine water hardness, hardness due to calcium alone and hardness due to magnesium alone. Hall Laboratories, Inc.

248 Boiler Water Treatment — Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used. National Aluminate Corp.

249 Ion Exchange Systems — "Amberlite Monobed Deionization" is a 12-pp miniature textbook covering the history, behavior, present performance, and potential uses of the Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of various combinations of exchangers are explained in text and equations. Also discussed are operating costs, equipment costs, quality of product derived, rinse requirements. The Resinous Products Div., Rohm & Haas Co.

250 Pocket Book on Chemicals — Here's a handly little 28-pp manual covering chemical products used by the power engineer. Most of those listed are water treating chemicals, but there's also a brine treatment, a fuel oil sludge dispersant, a soot remover, and protective coating. Tells what

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each product does and how and where to use it. Includes a helpful application chart. Western Chemical Co.

251 Boiler Water Manual — Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-pp technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater system, condensate returns, flushing. Proportioneers, Inc.

252 Water Softening Equipment — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Illustrates a fully automatic softener. The Permutit Co.

253 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations to suit individual plant requirements. Covers pretreatment, internal treatment, treatment application, blowdown adjustment and test control. Filled with illustrations, also describes available equipment and includes a reference bibliography of literature on specific formulations. Dearborn Chemical Co.

254 Boiler Corrosion — A 12-pp article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its Effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity, physical factors evaluated. W. H. & L. D. Betz.

255 Zeolite Water Softeners — Publication 4530, 16 pp, presents hydrogen zeolite (cation exchange) water softening equipment. Gives complete description of the process and the field of application, showing advantage of hydrogen zeolite softening and its relation to sodium zeolite softening process. Bulletin not only provides an exhaustive explanation of the new process but of the zeolites themselves. Cochrane Corp.

256 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. The Bird-Archer Co.

257 Slurry Type Softener — Six-pp Bulletin W-212-B6 describes a slurry type precipitating softener and coagulator in which energy for floc preparation is mechanical, explaining and illustrating flow circuit. An excellent question-and-answer appraisal of system is included, equipment pictured. Worthington Pump and Machinery Corp.

258 Organics in Water Treatment — Here's an interesting 4-pp folder describing the need for organics in altering the nature of sludge in order to make it nonadherent. Covers theoretical and practical considerations involved in use of organics; describes manner in which they overcome problems of sludge. Power Chemicals Div., E. F. Drew & Co., Inc.

FUEL OILS, LUBRICANTS

259 Fuel Oil Treatment — By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. E. F. Drew & Co., Inc.

260 Grease Application Devices — The development and use of many types of lubricating devices are discussed in an excellent article in Vol. 36, No. 9 of Lubrication, company's technical publication on lubricants. Covers the pressure gun, spring type grease cups and several types of power driven grease lubricators, explaining such points as the judicious use of pressure measured lubrication, pumpability characteristics of lubricants. The Texas Co.

261 Air Compressor Lubrication Manual — Valuable information on air compressor maintenance is contained in this 40-pp illustrated book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, and safety precautions. Cities Service Oil Co.

262 Diesels, Their Fuels and Lubricants — This 46-pp book offers a well organized and attractive presentation of practical information on diesel engines, covering their history and economics as well as their design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and diesel oil purification and filtration. Includes a discussion of fuel and lubricating oil required. Sinclair Refining Co.

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263 Steam Condensers with Reserve Flow — Eight-pp Catalog 410-1 describes a "self-cleaning" reverse-flow condenser for power plant service, designed to virtually eliminate cleaning down time and, in the case of divided water box condensers, eliminate operation at partial load. C. H. Wheeler Mfg. Co.

264 Ejector Instruction Manual — Bulletin J-50-7 is a 36-pp handbook covering operation, selection, installation and maintenance of steam jet air ejectors. Discusses twin and triple element ejectors, surface and jet inter- and after-condensers, isolating valves, drain traps, steam and back

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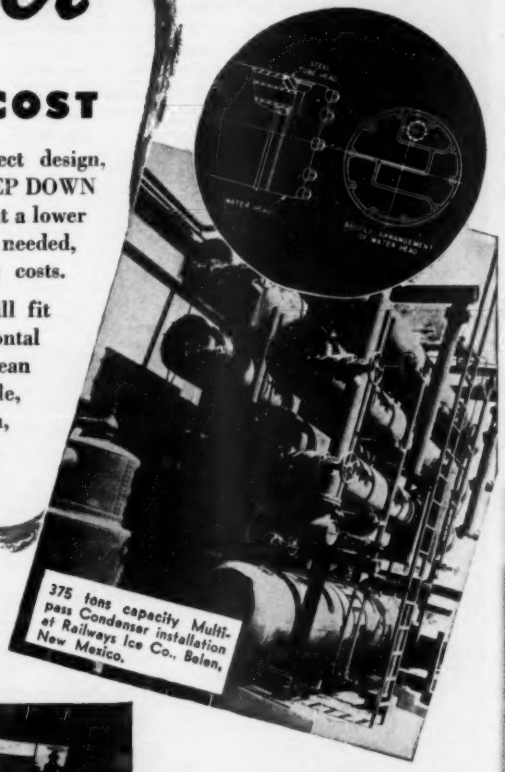

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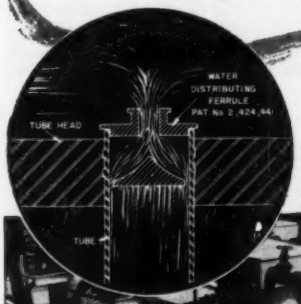

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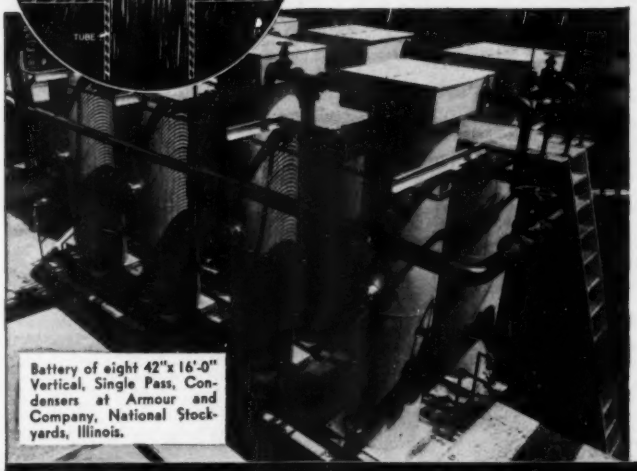

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265 Steam Condensers — Bulletin 102, 24 pp, is a comprehensive presentation of manufacturer's steam condensers and includes photos of six typical installations as well as a section of engineering data, a discussion of air removal equipment, and a chapter on condenser maintenance. Such special equipment as company's Wizard injector to seal small leaks while condenser is in operation, air erosion eliminators, divers lights and port gages are also described. Condenser Service & Engineering Co., Inc.

HEATERS, HEATING

266 Water Heaters — Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. Davis Engineering Corp.

267 Heat Exchangers — Bulletin 114, a small folder, gives concise information on company's Aero heat exchanger with balanced wet bulb control designed to cool engines or process equipment, coolants and lubricants, liquids and gases for processing operations. Cutaway drawing shows how exchanger operates, installation photos show some applications. Niagara Blower Co.

COAL, ASH HANDLING

268 Spreader Stoker — Bulletin 890, 40 pp, describes a spreader stoker with overthrow rotor designed to provide uniform fuel distribution. Discusses advantages of this type of stoker, including its efficiency in the burning of many grades of coal and in handling of fluctuating loads. Power-operated and hand-operated dumping grates and stationary grates are shown. Detroit Stoker Co.

269 Coal Handling Equipment — Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated, covers concrete and tile silos, cylindrical steel tanks, suspended steel bunkers. Gifford-Wood Co.

270 Spreader Stoker Selection — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

271 Spreader Stoker Data — This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

272 Coal Scale — Bulletin 0250, 12 pp, describes a pressure-tight, automatic coal scale, its construction and operation. How beam system, electrical components and linkages are protected from exposure to coal dust, explained and illustrated. Typical installations pictured. Richardson Scale Co.

273 Efficient Coal Preparation — Facts and features concerning improved coal preparation for power plants are presented in this 8-pp illustrated booklet. Shows how coal is split, not crushed, by rolling ring principle utilized in company's equipment to provide better combustion and reduced ashpit loss through uniform low-cost coal sizing. Tables show relation of sizing of coal to ashpit loss. American Pulverizer Co.

274 Ash Handling Systems — This 24-pp booklet offers technical information on hydraulic and pneumatic ash and fly-ash handling systems. Compiled in question and answer form. Discusses elements and advantages of various systems and disposal schemes. Schematic drawings of arrangements under specific conditions, diagrams of arrangements included. Beaumont Birch Co.

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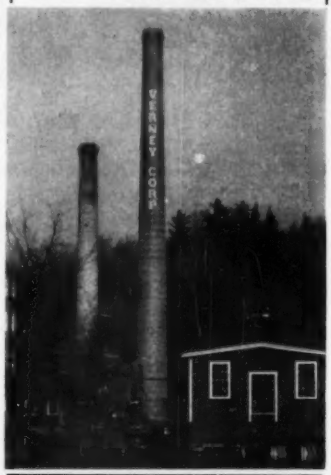

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276 Teflon Packings — Form AD143 offers 8 pp of information on packings and gasketing material made of Teflon, giving properties, typical and special applications. Styles and types are pictured, construction described, sizes given. Includes chapter on toxicology of Teflon at extremely high temperatures. The Garlock Packing Co.

277 Manual on Packings — Containing 84 pp of helpful engineering and ordering information, Catalog 40 covers packings for practically every service. Illustrates each type, gives sizes, construction and application details. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

COOLING

278 Industrial Dry Coolers — Illustrated Bulletin DC-50, 12 pp, presents company's line of dry cooling equipment for small, "in-between" and heavy-duty cooling jobs and includes three new models. Two of these are small "portable" units and the third a medium-size unit. Although designed primarily for cooling engine jacket water, they can also be used for cooling natural gas, lube oil, fluids of refining stages. Includes rating tables. The Marley Co., Inc.

279 Cooler with Fins — A new oil and water cooler and the several advantages provided by its improved design are described in 20-pp Bulletin 1020. Explains how company's LK-Fin Cooler, distinguished by use of helically-finned heat transfer elements instead of bare tubes, is a lighter, more

(*Continued on page 122*)

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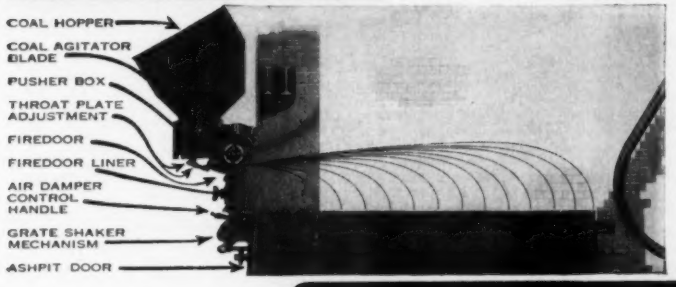

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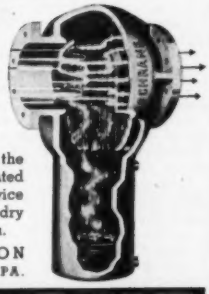

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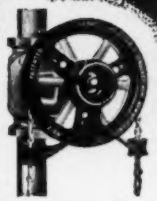

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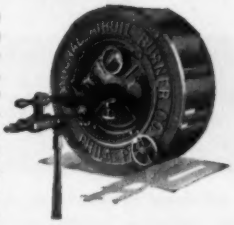
FOR YOUR "CONICAL FLAME" REQUIREMENTS

UNIVERSAL (REGISTER TYPE) COMBUSTION UNIT

Can be furnished with Gas Burners or steam or mechanical atomizing Oil Burners, for either natural or forced draft. Air vanes are variable independently of each other and adjustable or instantly reversible from left to right hand turbulence or vice versa as a unit. Has a dual feature for controlling air volume, independent of turbulence. Capacities up to 500 gals. of oil (60,000 lbs. steam) per hour.

MECHANICAL-PRESSURE ATOMIZING OIL BURNERS

Mechanical-pressure atomizing (marine type) oil burners for firing high pressure steam boilers. Capacities 10 to 500 gals. per hour. Require oil pressures of 75 to 300 lbs. per sq. in. and oil temperatures up to 300° F., depending on grade of fuel oil and furnace design. Standard or wide range types. Air Registers available for natural or forced draft.



LOW AIR PRESSURE OIL BURNERS

Type L-A-P Burner and Register, shown mounted on furnace wall with Indicating Air and Oil Control Valves. The Type L-A-P Oil Burner is for use with low pressure air for firing forging, reheating, heat treating furnaces, crucibles and other metal melting furnaces, core ovens, galvanizing kettles, dryers, bake ovens, cookers, air heaters, kilns, glass tanks, glory holes, enameling furnaces, asphalt kettles and other process furnaces. (Patented July, 1943.)

Where it is preferable to use the cone flame for firing steam boilers and other industrial furnaces, NATIONAL AIROIL BURNER CO. offers these Register Type Combustion Units in several types, and models for either natural or forced draft.

NATIONAL AIROIL BURNER CO. stands ready to serve your every need or special problem when it comes to Oil Burners—Gas Burners and allied equipment. We feel that you'll be interested in the full particulars we give regarding your oil-gas combustion requirements . . . write us today, won't you?

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

NATIONAL AIROIL BURNER COMPANY, INC.

1255 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard, Houston 6, Texas

7 ADVANTAGES of the Duplex Strainer

1. Full control obtained by 2½ turns of single handwheel. Operates rapidly and easily.

2. TWO large identical basket strainers, either of which can be removed for cleaning without interruption to the flow.

3. Rotary valve motion eliminates dirty or clogged seats as the discs are always in contact with the seats.

4. Operating mechanism is on the downstream side of the strainer, not in the path of flow and in contact with clean strained liquid only.

5. Designed for minimum pressure drop and low maintenance (only one stuffing box).

6. Used on house service lines in major generating stations and on fuel oil lines in utility and heavy industrial plants.

7. Available in various metals and alloys for nearly all liquids. 4-inch to 24-inch pipe sizes.

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District offices are listed in telephone directories as "R-S Products Corp'n Valves" or write direct.

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R-S PRODUCTS CORPORATION
4600 Germantown Avenue
Philadelphia 44, Pa.

An S. Morgan Smith Company Subsidiary

CATALOG LIBRARY

(Continued from page 118)

compact and less costly unit for a given cooling service. Diagrams show comparisons of length and number of tubes and size of units for equivalent heat transfer surface. Also described are design details which provide effective heat transfer, permit free expansion of tube bundle, prevent leakage. The Griscom-Russell Co.

FANS, BLOWERS

280 Mechanical Draft Fans — An extensive line of mechanical draft fans for both forced and induced draft service is described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, also includes performance curves showing efficiencies of various types of fans. Gives construction features, drive arrangements, mounting methods. The Green Fuel Economizer Co., Inc.

281 Axial Flow Blowers — In this 6-pp illustrated bulletin are described axial flow blowers of both turbine-driven and motor-driven types. Gives capacity and dimensional data, operating range and specifications on both types. Also describes draft inducers. L. J. Wing Mfg. Co.

282 Blowers and Accessories — Engineering and dimensional information on low, medium and high capacity blowers is given in this recently released 6-pp bulletin. Pictures some installations, also accessories for use with the blowers. Blower-Stoker Div., Read Standard Corp.

DUST CONTROL

283 The Efficiency of Decantation — The decantation principle as applied in dust control systems and how it separates high carbon content particles from fly ash for re-injection as fuel is discussed in illustrated Catalog 260D. A typical installation is diagrammed and efficiency curves included. Long run economy and other advantages listed. The Thermix Corp., Prat-Daniel Corp.

284 Fly Ash Elimination — Power engineers will find this 30-pp booklet outstanding among material on this subject. It presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors usinge entrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash — not as a panacea for all cinder and fly ash problems. Also gives engineering data on single and double hopper installations. Western Precipitation Corp.

285 Dust Collecting Efficiency — How the higher and narrower inlet utilized in company's tubular dust collector contributes to more efficient dust collecting is explained in this illustrated bulletin. Prat-Daniel Corp.

OTHER EQUIPMENT

286 The ABC of CO^2 — An interesting, readable text covering the role of carbon dioxide in combustion efficiency. 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion and tells how to determine percentage of CO^2 in flue gases. CO^2 as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. Includes scales of total heat losses of various types of coal, fuel oils and gas, also case histories of savings realized through increased CO^2 percentage. The Hays Corp.

287 Fundamentals of Hydraulics — Technical Bulletin B-4 is a newly revised 44-pp guidebook covering essential information on hydraulic systems, maintenance trouble-shooting and selection of proper fluids. Besides offering well-organized reference data to engineering personnel, this book is suggested as a training manual for maintenance supervisors, operators and apprentices. It features specially prepared phantom and cutaway drawings illustrating functions of basic types of valves, pumps, hydraulic motors, torque converters. Shows function of each component part. Sun Oil Co.

288 Transmission Belting — Catalog M-9922, 28 pp, gives detailed design, engineering and performance data on transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included. United States Rubber Co.

289 Turbine Catalog Collection — This is a valuable collection of bulletins covering a complete description of solid wheel turbines. They feature cross section drawings of typical units for both moderate and high steam pressure conditions. Includes data on speed increasing and reduction gears. The Terry Steam Turbine Co.

290 Steels for Hot Spots — This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical properties of 21 steels. United States Steel.

291 Paints to Beat Corrosion — This 8-pp illustrated bulletin is devoted to company's line of anti-corrosive paints. Discusses their sub-oxide of lead base and other technical properties and points out savings in time and money afforded by the use of these rust-inhibitive coatings. Describes primers, finishing coats and single coats available; tells how to apply them. Also discusses painting of galvanized structures. Subox, Inc.

292 Power Plant Communication Systems — This 25-pp brochure describes a high and low level intercom system designed and built especially for power plants — a system readily installed and permitting two-way conversations over close-speaking microphones and receivers (they look like ordinary telephone handsets) as well as paging over loudspeakers suited to different noise levels. Booklet tells what the system can do for your plant and includes photos of the equipment used. Gai-Tronics Corp.

CLASSIFIED ADVERTISING

EQUIPMENT FOR SALE

Mixed Pressure Kerr Turbine and Condenser with Allis-Chalmers 600 amp 240 volt generator and exciter. Chase Steam Engine with Western Electric 40 kw 240 volt generator and exciter. 450 hp Murray-Corliss Tandem Compound Steam Engine, 4" x 8" Triplex Gould Feed Water Pump. 21,000 gal capacity Permutit Water Softener. Cochrane Feed Water Heater and relief valve. 2-Laclede Chain Grate Stokers. Used Valves 3½ to 10". Phone collect GArfield 1322, Saxony Mills, St. Louis, Mo.

SAVE
Used
Electric Motors
1/20 HP to 600 HP
also
Misc. Elect. Equipment
Write, Wire or Call R. E. Miller
International Milling Company
Minneapolis, Minnesota

WANTED

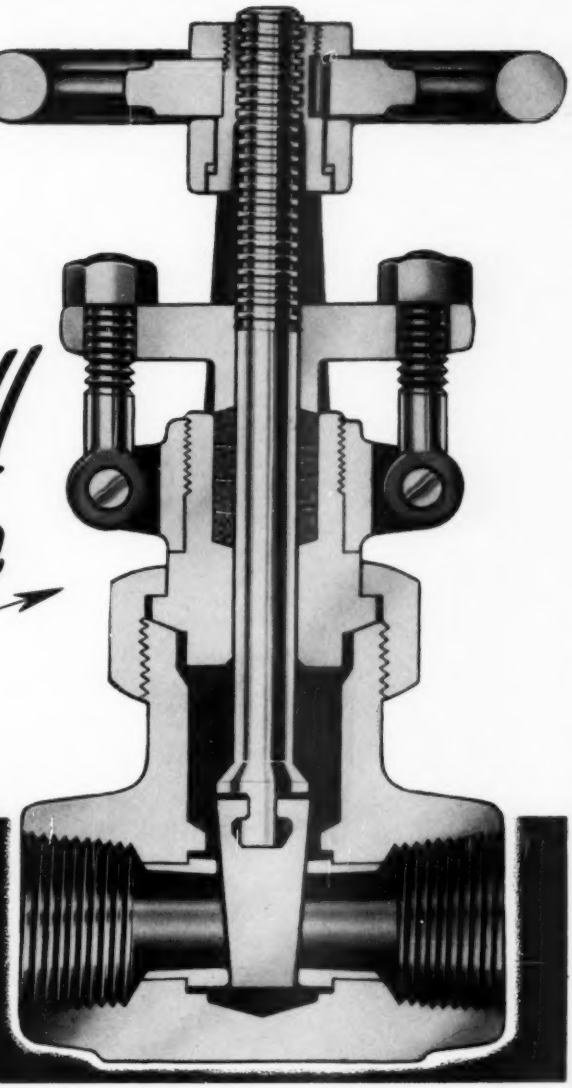
4 — 400 AMP. oil circuit breakers similar to Westinghouse Model F-124A. Must have interrupting capacity of 50,000 kva, complete with instantaneous trip and indicating ammeter for 3-phase, 2500 volt circuits.
6 — B. A. Deion fuse disconnects for 2500 volts — 400 amp.
1 — 1000 ampere blade disconnect for 3 phase 2500-volt circuit. Address Box 1658, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill.

"ATTENTION ENGINEERS — YOU GET THE COMMISSION WHEN YOU USE OUR SLUDGE-SOLVENT OR SOOT-REMOVER. For particulars write Atmonic Chemical Co., P. O. Box 371, Taunton, Mass."

You can

Repack Under Full Pressure

with a



Chapman List 960

No pressure is transmitted to the stuffing box of a Chapman List 960 when the valve is in the open position . . . you can always repack it easily, fast, without stopping the flow through the valve. What's more, it's a tougher — more rugged — valve that reduces many other maintenance problems.

Take for instance, the wedge faces — they're hardened to 800 Brinell by the exclusive Malcomizing process to give peak wear resistance. Seat rings, too, have unusual wear-resisting and non-galling characteristics. And, in addition, recent design changes have resulted in stem and wedge gate connections 50% stronger than before.

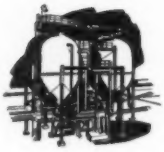
Write *today* for detailed technical information. The Chapman List 960 is available in sizes from ¼" to 2", either metal to metal or gasketed joint. Rising stem with yoke (as illustrated) or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. For higher pressures specify List 990.

The Chapman Valve Manufacturing Company

INDIAN ORCHARD, MASSACHUSETTS

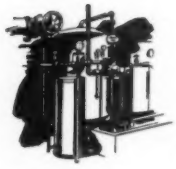
5 WAYS TO → SOFT, CLEAR, PURE WATER

. . . for Power Plants



1. SLUDGE BLANKET HOT LIME SODA. *Application of the sludge blanket to hot lime soda treatment reduces silica in boiler feed make-up, produces high quality steam.*

2. HOT ZEOLITE—PERMUTIT Q. *Subsequent treatment of water from hot lime soda treatment yields effluent of zero hardness. Permutit Q, a styrene base mineral resistant to high temperatures, replaces second stage phosphate treatment.*



3. SILICA REMOVAL PLUS DEMINERALIZATION. *Demineralization by cold ion exchange processes produces water comparable to distilled water at a fraction of the cost of distillation. Treatment by anion exchange resin, Permutit S, reduces silica to less than 0.5 ppm.*

4. DEAERATING HEATER. *The Permutit Deaerating Heater, utilizing exhaust or bled steam, prevents corrosion of feed lines, stage heaters, economizers, and boilers, by removing oxygen and free CO_2. Capacities from 12,000 to 1,400,000 pounds per hour are in service.*

5. PRECIPITATOR. *The Permutit Precipitator is used to lower alkalinity, reduce hardness, and help to remove turbidity, color, taste and odor. It can also be used to reduce silica.*

These basic processes, plus Permutit skill—can solve your water conditioning problem

Other processes include mixed bed demineralization and cold zeolite water softening. Whatever your problem, Permutit has equipment to solve it. Write for free information to The Permutit Company, Dept. PE-7, 330 West 42nd St., New York 18, N. Y., or to Permutit Company of Canada, Ltd., 6975 Jeanne Mance St., Montreal.

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